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ABSTRACT

This document consists of: (1) an introduction; (2) the first and last chapters of Harold Dunkel's manuscript titled "Writ in Water: The Epitaph of Educational Innovation"; (3) an invited address (presented at a session sponsored by an American Educational Research Association Special Interest Group on the Creation and Utilization of Curriculum Knowledge) which used historical inquiry to shed light on contemporary problems, and two responses to the address. The invited address, "Science, Technology, and the Secondary School Curriculum in the Twentieth Century" by William Connell, examines the degree of success that ideas and practices in the teaching of science and technology have had in recasting views on an appropriate curriculum in secondary education, through which intellectual, expressive, and social development might be fostered. The responses are "The Conceptual Ecology of Science Education: A Response" by George Posner and "Toward a Progressive Interpretation of Science Curricula: A Response" by William Schubert. The two chapters in the Dunkel manuscript (titled "The Coming of German Innovation" and "The Life-Cycles and Contributions of Educational Movements") examine reform during the last century and suggest what can be learned from this about today's more controversial innovations. (JN)

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# CONCEPTIONS OF CURRICULUM KNOWLEDGE: FOCUS ON HISTORICAL MOVEMENTS


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# CONCEPTIONS OF CURRICULUM KNOWLEDGE:

# FOCUS ON HISTORICAL MOVEMENTS

EDITED

BY

PETER PEREIRA AND THOMAS W. ROBY

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# INTRODUCTION

Peter Pereira

Formal education in the United States has become the panacea for the problems of the twentieth century much as the wonder tonics of the nineteenth century were supposed to cure all physical ailments. People may differ about the proper way to address our social, economic, environmental, and international problems, but they share a common belief that these problems can only be solved if we have an educated and responsible population. To be sure, the 'moral majority' has a different vision of how schools should go about their work than does the 'far left'. Yet both see schools as an instrument for social improvement.

This is not a new development in American thought. Historically, the purposes of American schools have always been defined in terms of their social functions. During early Colonial times, schools were founded to develop a literate, Bible reading populace so that the community could sucessfully complete its errand in the New World. In the eighteenth century, the Northwest Ordinance proclaimed that "...religion, morality and knowledge being necessary to good government and the happiness of mankind, schools and the means of education shall ever be encouraged."[1] In the Jacksonian era formal education was seen as the most effective way to create the rational and wise decision-maker essential for the preservation of America's growing democracy.

The pressures brought about by increased immigration and rapid industrialization in the late nineteenth century forced the schools to further expand their function. They now were supposed to Americanize millions of non-English speaking new-comers, teaching them English, democratic values, and vocational skills. This placed huge added burdens on the schools, and it comes as no surprise that schools were not always up to the task. "The English language taught in the schools was largely prescriptive, its grammar artificial and usage canonical. ... Americanization required clean hands, regular use of the toothbrush, a balanced diet, patient industry, neat dress, and an idyllic middle-class family life."[2]

At this point the story of the growth of American public schools is fairly well known. Whether one accepts the idea that schools were a melting pot or whether one sees them as a vehicle for perpetuating ethnic and social class differences, their relationships with the larger social matrix have been well explored. What is less well known is the history of the techniques adopted by educators to deal with the enormous problems they faced. This history is taken up in the first selection in this volume, "Writ in Water: the Epitaph of Educational Innovation." As Harold Dunkel shows us, when organized into educational movements by a comprehensive and convincing slogan system, these techniques have a history and a continuity of their own. There is as much, if not more, to be learned from the study of the internal functioning of educational phenomena as there is from the study of the function they play for the larger society.

Those of us who are involved in curriculum work -- whether in schools on a day-to-day basis or in universities teaching curriculum courses and writing theoretical papers -- tend to forget this aspect of our educational history. We have our own techniques and procedures, rationalized out of

our experience or the recent past, with which we attack our problems. These function as heuristic devices, allowing us to cope with our world, but seldom are they as powerful, or as novel, as we would like to claim. Professor Dunkel's survey of four American educational movements steming from the work of four nineteenth century German philosophers serves to remind us that many, if not most, of the devices we currently use have predecessors. If we take this insight seriously, it changes the way we view our work. Instead of seeing ourselves on the leading edge, we must see ourselves in the context of generations of workers who have been involved with similar problems and used similar devices.

This insight also changes the way we view curriculum problems. Because any curriculum problem is imbedded in the present state of affairs, the road to its resolution requires us to understand current conditions. Rarely, if ever, are we in a situation where we can start completely afresh. Therefore, we must form a picture of the present situation by systematically studying all the factors involved. So we make a study of the learners to uncover their salient characteristics. We study the teachers to discover their capacities and limitations. We look at subject matter o see the ways in which itis, or might be, organized. Further, we must study the network of social and cultural contexts which surround our situation and have an impact upon it. These four commonplaces, delineated by Professor Dunkel in collaboration with Joseph J. Schwab,[3] are well known and have been described elsewhere. But it is often forgotten that present conditions have a history which it also would be well for us to understand; and, as Professor Dunkel points out, so do proposed solutions. Popular innovations have a way of growing into educational movements. An understanding of the dynamics of educational movements and their contributions to the present situation should help us to gauge the probability of long-term benefits from our currently favored innovations. The analysis of educational movements not only makes an important contribution to our understanding of curriculum history; it also can be put to use in the solution of curriculum problems.

An interest in the nature of curriculum knowledge creation and utilization prompted the formation of a Special Interest Group on the Creation and Utilization of Curriculum Knowledge within the American Educational Research Association. Since its founding in 1971, the SIG has sponsored papers and symposia at the Annual Meeting of the Association. In 1983, at the Annual Meeting in Montreal, the SIG sponsored a newly designed, invited address which used historical inquiry to shed light on contemporary problems. The second paper in this volume, William F. Connell's "Science, Technology, and the Secondary School Curriculum in the Twentieth Century," was the invited paper presented at this session. The two short responses to this paper which follow, "Toward a Progressive Interpretation of Science Curricula" and "The Conceptual Ecology of Science Education," were also presented at that time. Because criticisms of science education have become more widespread, the issues the papers raise are still in need of urgent consideration. The SIG and the authors have kindly given permission to have their papers reproduced here. It must be

fully understood, however, that the present publication has no endorsement by the American Educaional Research Associaton.

Though broader in scope, in a sense Professor Connell takes up where Professor Dunkel left off. The scientific and technical advances made in Germany at the turn of the century were due in no small part to their development of science curricula in schools as well as in universities. Visitors went to Germany to observe its science teaching just as earlier they had crossed the oceans to study Froebel's kindergartens. Professor Connell describes the development of science education in the twentieth century as a long-term educational movement in which scientific education has struggled for recognition with the prevailing literary tradition. Though more a description of general cultural change than of an innovation, one of the interesting points of Connell's analysis is the similarities which recur as various curricular emphases become predominant. The situation in science education today looks much like the situation in the 1930's. The dominant emphasis is on the the social applications and responsibilities of science, and the impetus for reform seems to be coming from outside the schools. The innovations which may result are more likely to have a positive effect if science educators were to read the papers pesented here.

NOTES

1. As quoted in Rush Welter, Popular Education and Democratic Thought in America (New York: Columbia University Press, 1958), 25.

2. David Tyack, Turning Points in American Educational History (Waltham, MA: Blaisdell Publishing Co., 1967), 229.

3. One recent example which comes to mind is Peter Pereira, "Deliberation and the Practical Arts," Journal of Curriculum Studies, 16 (October-December, 1984) in which further references to the literature about commonplaces can be found.

# WRIT IN WATER: THE EPITAPH OF EDUCATIONAL INNOVATION

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FOREWORD

Thomas W. Roby

The failures of educational innovations and reforms over the years, beginning with the disapointing effects of Socrates' streetcorner discussions for moving the Athenians towards virtue, is one of the most instructive unwritten chapters in educational history. In an effort to help fill this gap the editors present the first and last chapter of Harold Dunkel's manuscript, Writ In Water: The Epitaph Of Educational Innovation. Professor Dunkel (Professor Emeritus, Department of Education, University of Chicago) brings a useful objectivity to this study. He examines educational reform in the last century, about which we can be relatively dispassionate, then suggests what we might learn about today's more controversial innovations. By pointing out the recurrent character of many reforms, he enables us to focus on what we have come to think of as educational RIPs (Recurrent Instructional Problems), an acronym which is its own anti-instance. Were educators to take seriously the perennial character of these problems, they might be able to find more consistent mitigations, perhaps even some viable solutions. The present chapters open the possibility for more continuity with the past than is now evident and, despite their title, for a more constructive future. We hope they lead to further such studies.

The two chapters presented here can only outline the main line of Professor Dunkel's argument and report the generalizations which he has made. The details of his argument and the support for his generalizations are thoroughly documented in the middle chapters of the book. So that readers can get an idea of the scope of these chapters, and perhaps to whet their appetites for more, we shall list the Table of Contents for the entire manuscript. Those who are interested further should write to us at the address given on the title page of this volume.

1. The Coming of German Innovation
2. Hegel and the St. Louis Philosophical Society
3. Harris and Hegelian Schooling
4. Rosenkranz's Padagogik as a Force in Hegelian Schooling
5. Hegelian Adult Education
6. Herbart and his German Disciples
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8. Froebel and the Beginnings of the Kindergarten Movement
9. Two American Froebelians: Elizabeth Peabody and Susan Blow
10. Wundt's Students: G. Stanley Hall and Hugo Munsterberg
11. Wundt's Student: Charles Judd
12. The Life-Cycles and Contributions of Educational Movements

PRECIS

The history of American education is marked by a seemingly endless succession of "educational movements." These movements, organized by slogan systems which justify and more or less closely articulate various combinations of educational ideas and practices, come into being, flourish for a while, and then fade away. Unfortunately, the final stage does not produce obituaries and post-mortems. As a result, we never know when or why the movement perished. When due to the proclivity of the American educator to continually reinvent the wheel the movement is born again, adorned with trendier contemporary languages, everything, including the same mistakes, starts from scratch. As a discipline or field of study, education is probably unique in the degree to which it fails to profit from previous experience.

In addition to the various stages in their life cycles, movements exhibit other interesting characteristics. First is the symbiotic relations between the educator who conceives and popularizes the slogan system and the movement he thus creates. He cherishes the movement, and usually the movement serves as a career vehicle for him. Second is the relation between the movement and its followers, the people who buy the books, subscribe to the journals, and attend the seminars. By and large these are the relations common wherever "followers" exist. But some additional factors are mentioned. Finally, movements vary because of the different degrees of complexity involved in the symbol system. It is easier to be a leader or follower of a simple set of concepts than of a complex system.

The generalizations that form the bulk of this paper are based on detailed study of four educational movements. The four movements date from the late nineteenth and early twentieth centuries. This temporal distance should help us avoid our current predilections and prejudices. They are all German in origin, for Prussia was at that time the bell wether in educational innovation and reform. They vary in the levels at which each affected schooling. The St. Louis Hegelians were themselves mainly educators of adults. But they worked hard to make Rosenkranz' Pedagogy as a System available as a text for use in normal schools and the new Departments of Education. The American Herbartians engaged in training teachers primarily for elementary schools. Froebel had fastened on early childhood education, and the American kindergartners focused on the same point. The students of Wundt came late, after the American educational system was in place. As professors of education and of psychology, they tended to deal with all levels of schooling.

With movements looming so large on the contemporary educational landscape, they seem to merit more attention than they have received.

**The Nineteenth Century Social Matrix**

In the period 1860-1910, American education, particularly public schooling, underwent enormous growth. The number of elementary and secondary schools, the numbers of teachers and students, the average length of the school year, and the number of days of actual attendance at the elementary and secondary levels all expanded enormously.

The factors producing this development, generally labeled the "American public school movement," were numerous and varied and have been rendered familiar by a number of students in recent years. Hence a very cursory glance at a few of them that are most relevant here will suffice.

Ever-increasing throngs of immigrants were pouring into the country. They usually professed different religions and spoke different languages from those which had characterized the youthful United States. They came from different cultures with different social and political institutions. Many of them were unskilled, and those who had some trade or profession faced formidable barriers in attempting to exercise their skills in a new industrial setting, using a strange language and confronting unfamiliar social and political arrangements. Fear mounted among the earlier citizens lest this inundation sunder the new nation into social chaos or political anarchy. Charitable agencies like the settlement house would do what they could to aid in the assimilation of the adults, but the best hope of complete acculturation lay in the children. The school was, consequently, to be the "melting pot," which would amalgamate the new elements with the old into a new alloy not too different from that previously existing.

Industrialization and consequent urbanization produced a variety of consequences. Even native-born families were uprooted from their rural communities and transplanted into the disorder and anonymity of the city, often the slum. When, as was frequently the case, both parents worked long shifts in factories, children were unsupervised and an easy prey to delinquency. Thus the custodial function of the school became important. But perhaps the school could do more than keep the child from running wild on the streets; it could inculcate those habits and attitudes (such as promptness, accuracy, consideration for others) that were seen as essential for life in an urban, industrial, and democratic society.

Industrialization was also in the early stages of placing a new premium on learning. In the more primitive rural setting, which had characterized much of America a relatively few years before, the child who attended school for only a few days a year and ended with little more than a rudimentary knowledge of the three R's suffered relatively slight, if any, social or vocational handicap as a result and as an adult could still play a full role in the community. The manufacturing and merchandising activities of the city were changing that situation. More numerous and new

career lines requiring in varied ways and to various degrees the abilities conferred by schooling were beginning to appear. As W.T. Harris frequently pointed out, "directive power" was becoming more important than "muscle power." As greater opportunities opened for those with more schooling, Americans were beginning to view, even if still only dimly, education as the ladder for social mobility.

At the same time the possibility of an illiterate, untrained, urban proletariat appeared a real threat to public order and public weal. Such a group, limited in its opportunities for employment and debarred from what was becoming the mainstream of American life, would be a prime source for criminals and revolutionaries. Schooling for children could serve as a preventive insofar as it could not only teach useful skills and enhance employment opportunities but also presumably could give insight into the nature and value of existing social institutions and thus dampen the urge for revolution.

Finally, the development of agriculture and industry and the exploitation of natural resources had enabled many in the population to acquire money and property to an extent far beyond what they had ever known before. But this affluence was seen as having its dark side because it was thought to lead to a preoccupation with material things to the neglect of spiritual values. This worry was exacerbated by uneasiness about religion lest faith be eroded by the theory of evolution and the higher Biblical criticism as well as by the materialistic spirit. Since many regarded religion as the only possible firm basis for morality, a weakening of religious belief seemed to them certain to be accompanied by moral decay. Although because of the doctrine of the separation between church and state the public school could not attempt to bolster religion, schooling could at least attempt to inculcate virtuous habits and aspirations and could give the child some glimpse of the finer things through work in music and art.

**Effects of Social Changes on Education**

For these and other reasons, educational and political leaders continued to urge the expansion of education at public expense, and the dominant elements among the citizenry supported their proposals. The educational innovations examined here owed part of their popularity to the fact that they were responsive to these larger concerns as well as to the more immediate problems of teaching and learning.

As a result, school organization and its attendant bureaucracy became continually more complicated. No longer was it merely a matter of a local set of school trustees hiring some young person from the neighborhood to "keep" a one-room school for a few months when children and young people were not otherwise better employed. Urbanization and consequent centralization of schools were producing the multi-teacher school with a head teacher or principal in charge; still larger units were making familiar positions like "superintendent," "school board member," "regent,"

"state superintendent," and all the rest. In other words the number of those specifically charged in some capacity with direction and administration (as distinct from teaching) likewise constantly increased.

Superintendents, members of school boards and their like, publicly charged with the conduct of the educational enterprise, were spending increasing amounts of public monies on it. Were they doing the right things and doing them in the right way? Were the educational programs that they offered satisfying personal demands and expectations as well as meeting social necessities?

Teaching was becoming more of a career and making some attempts at becoming a profession. Teachers were being better paid to teach -- even if still they were not paid much. Were they doing a competent job? If superintendents, principals, and similar functionaries were to supervise the teachers' efforts, what criteria did these supervisors have for judging classroom practices? If current teaching was unsatisfactory, what could be done through normal schools, teachers' institutes, teachers' reading circles, or other devices to improve the competence of teachers both before and after they entered the profession? What did a teacher need to know in order to teach effectively? Were some teaching methods more effective than others? What were they ? Could the better methods be taught to teachers and would-be teachers, and, if so, how?

In short, education in the latter part of the nineteenth century was well on its way to becoming the major American enterprise it has since been. The amount of money spent on it, the number of people engaged in it, and the size of the public interested in it all served to arouse greater concern for education's being done well and not just merely done in some fashion or other.

Adequate and sufficiently coherent answers to the problems attendant upon this mighty upsurge did not seem likely to be achieved **ad hoc** -- at least not answers which would satisfy reluctant taxpayers, determined pressure-groups, concerned parents, an inquisitive press, and skeptical fellow-professionals. Some sort of "theory," some kind of codified "science" or "art" of education seemed requisite for the proper assessment and ordering of educational institutions, goals, and procedures. Since little of this kind was available in America, those seeking some conceptual framework naturally turned to Germany, which had been the great educational innovator in the first half of the nineteenth century and where educational movements reportedly based on philosophic theories were operating. The following pages will examine four major attempts to import German ideas and will trace the varied fates of these doctrines as they were transplanted to American soil.

**Regional Contexts: The Midwest**

The foregoing sketch ignores some gross and obvious differences between various regions of the country. Clearly, immigration, industrialization, urbanization and the other forces hit the eastern seaboard earlier than they did the middle west and the far west. This very fact had significance for the movements we will examine here. Because the impact of these social and economic forces was a more gradual process in the East, that region could work out its solutions more slowly and more **ad hoc.** And once New England had worked out its solutions, it tended to abide by them and to be (as editors of midwestern educational journals were fond of asserting in the last decades of the century) relatively uninterested in and even impervious to innovation. In the Midwest and West, where the problems came on a large scale and came quickly, the search for comprehensive views and solutions was more intense and self-conscious. As a result, many of the educational innovations through adoption and adaptation of German ideas were to a considerable extent Midwestern phenomena. Thus the Hegelians centered on St. Louis; Illinois State Normal University was the hub of Herbartianism; Froebel's kindergarten, although it also was popular in the eastern states, was especially cultivated in sites like St. Louis, Chicago, and Milwaukee. The number of citizens of German origin in these and some other Midwestern cities made for early knowledge and acceptance of German ideas there.

In this general geographical area the desire to improve schooling, particularly public schools, and the urge to search for educational theories should be viewed as part of a larger pattern and interest in "education" in a much broader sense than "schooling." Inhabitants of the hinterland were tired of being told by visitors from Europe and the older American settlements how uncouth and uncultivated they were. With the west won and the wilderness largely conquered, they were ready for "culture." A new level of general affluence -- to say nothing about the new huge fortunes from enterprises like meat packing, railroads and steel -- now put the natives in a position to buy the symbols of "culture" and to establish cultural institutions. The same period which saw the rise of public education also witnessed the founding of numerous colleges, art museums, symphony orchestras, public libraries, and innumerable philosophic, literary, musical, and artistic societies and study groups.

**Four Key Innovators**

In the hunt for educational theory the searchers turned to the doctrines of four nineteenth-century German "philosophers" who either had had definite educational theories themselves or whose thought had been seen by others to have some utility for education.

One of these was G .W. F. Hegel (1770-1831). Slow in producing his major works, once he had published his Phenomenology of the Spirit (1806) and his Science of Logic (1812), his contemporary fame was immense, and his

system became for several decades (approximately 1820-1840) the quasi-official philosophy of Prussia and the dominant view in the other German-speaking states. In Prussian education the fact that the two major figures in the educational bureaucracy of the period, Baron von Altenstein and Johannes Schulze, were both Hegelians made his views extremely influential in Prussian schooling at the time, particularly in regard to the curriculum of the gymnasium. And followers like Karl Rosenkranz and Gustav Thaulow elaborated and disseminated Hegel's educational ideas through their writings.

Hegelianism did not, however, reach American education through the medium of any of these German followers. Rather this influence arose through the efforts of the "St. Louis Hegelians" to study the master's works directly. The major figures in this so-called St. Louis Movement were H.C. Brokmeyer, William T. Harris, and Denton J. Snyder. Of these, Harris, who served as superintendent of schools in St. Louis (1868-1880) and as U.S. Commissioner of Education (1889-1906), was the one who did most to apply Hegelianism to American schooling. As the major educational "thinker" on the American scene between Horace Mann and John Dewey and as a prolific writer and ubiquitous speaker, he gave extensive exposure to Hegelian educational thought. In this effort he was for a while aided and abetted by Anna C. Brackett. Snyder, however, devoted his energies to what we would now call adult or continuing education.

A second source was Johannes Friedrich Herbart, (1776-1841). From his pre-doctoral days when he had served as tutor for a family in Switzerland, Herbart always had a major interest in education. During his lifetime, he produced a number of pedagogical works, and his philosophic system locked pedagogy into close relations with the other "sciences," most notably with ethics and psychology. Moreover during his tenure at the University of Konigsberg, he conducted a "pedagogical seminar."

For a number of reasons Herbart's theoretical and practical prescriptions made little headway during his lifetime. But approximately a quarter-century after his death, a Leipzig professor, Tuiskon Ziller, published his Foundations of Educative Instruction, organized a pedagogical society on Herbartian lines, and generally launched in Germany that educational movement known as "Herbartianism." Ziller's activities also gave a new impetus and importance to the work of some of Herbart's original students such as Karl Volkmar Story and H.G. Brzoska; and the pedagogical seminars of Ziller and of his student, Wilhelm Rein, became major dissemination centers of their form of Herbartianism.

Consequently, when in the last two decades of the nineteenth century American students began to visit Germany in search of some educational theory, they encountered that variety of Herbartianism espoused by Ziller and Rein. Herbartianism thus became a major American educational movement in the period 1888-1903 as spread by Charles DeGarmo, Charles and Frank McMurry, D.C. Van Liew, and others.

The third source was Friedrich Froebel (1782-1852). Unlike the other three figures whose doctrines and influence we shall examine here, he was not professionally a professor of philosophy. In fact his professional and scholarly credentials of any kind were rather meager. But as the "father of the kindergarten" he was generally regarded both in Europe and America as the "philosopher" of that popular movement, and hence, even if he holds the title only within quotation marks, he may be regarded as one of the German "philosophers" whose "thought" influenced education in both Europe and America. To a considerable degree his ideas were derived from, or at least are consonant with, the doctrine of Schelling, a philosopher who was a contemporary and close friend of Hegel's. But, as we shall see later, many other elements, such as ideas derived from his work in crystallography, formed part of his thought.

He drifted through a number of jobs, (surveying, work in a crystallography laboratory, etc.) but finally decided that his metier was the teaching of young children. His writings and his schools spread his reputation and the kindergarten idea in German territory, and in the years following 1840 he established kindergartens in a number of German cities, many of which became training centers for kindergartners who wished to establish their own schools.

But crucial for Froebel's influence in Europe and in America was the visit to his school at Liebenstein by Bertha, Baroness von Marenholtz-Bulow. With apparently no background or previous experience in education, she became entranced with Froebel and his work, and she devoted the rest of her life to lecturing throughout Europe on the wonders of the kindergarten. Her involvement made kindergartening an upper-class activity, and Prussia's prohibition of kindergartens in 1851 made it a liberal cause. A stream of American ladies went to Europe to observe kindergartens and to study kindergarten methods; and there was a counterflow of European ladies who, assured of an audience and customers, came to America, briefly or permanently, to lecture on the kindergarten or set up training centers. We will examine the work of two of his major American followers, Elizabeth Peabody and Susan Blow, in some detail.

The fourth source of educational ideas was Wilhelm Wundt (1832-1920). Educated mainly at the University of Tubingen, he qualified as a physician at Heidelberg and stayed on there as Privatdozent in physiology for almost ten years. This experience was an important episode in his life since physiology was then developing the general sort of precise research techniques which Wundt was later to take over into psychology. Eventually, as professor of philosophy at Leipzig, he opened in 1879 his famous institute for experimental psychology, which attracted a distinguished line of students from Europe and America.

The succession of Wundt's American students, of whom G. Stanley Hall was the first and Charles Hubbard Judd the last, brought some of Wundt's ideas (but only some of them) to America. William James also imported from Leipzig a German, Hugo Munsterburg, to run the laboratory for experimental

psychology at Harvard. Since Hall, Munsterburg, and Judd occupied positions of considerable influence in education and psychology, through their work Wundt had some impact on American schooling at the turn of the century.

In sum, then, the ideas of four German thinkers were borrowed by Americans in some fashion or other to make up for the lack of home-grown educational theory; and each school of thought was to some degree the source of educational innovation. By the beginning of the new century, educational innovation based on indigenous theory and research appeared. Yet these American innovators were far from isolated from the movements studied in this volume. John Dewey is a case in point. He began his scholarly life as an Hegelian and published his first three professional articles in Harris's Journal of Speculative Philosophy. He served on the executive council of the National Herbart Society and published in its annual Yearbooks. He wrote on the kindergarten, and his Psychology demonstrates his familiarity with Wundt's work. He served on the executive committee of the Illinois Association for Child Study. Edward L. Thorndike is another obvious instance, whose studies of the transfer of training had profound influence on schooling in the early decades of this century. Although he was never Wundt's student, his procedures owed much to the Leipzig Institute, and his work flourished in the general intellectual climate generated by the dominant position of Wundt's students in American psychology at the time.

What makes the study of these four interesting and instructive is the enormous variety between the cases. The original doctrines were markedly different. The knowledgeability and general caliber of their followers, both European and American, also differed enormously, as did the means these followers adopted to spread their chosen doctrine. The impacts on American education were similarly varied. In short we have four sharply contrasting case studies of the dissemination of educational ideas in America in roughly the last four decades of the nineteenth century. Examination of them does not merely illumine and clarify the educational thought and action of this period; it sheds considerable light on the transmission and dissemination of educational ideas and on the general processes of educational innovation.

**Characteristics of Innovation**

Innovation has been a word to conjure with in educational circles for the past three or four decades. Quite possibly there has often been an overemphasis on novelty. Sometimes it has seemed as if, whereas in an earlier period scholars and school people were able to get money to help them do better what they were already doing or to expand some ongoing activity, recently the fact that something existed and was functioning successfully has seemed prima facie ground for denying it further support. The large private foundations led the way. They wished to brand their mark on something distinctively theirs and thus to demonstrate to their trustees

and the general public that their largess of millions had actually produced something, and for that something to be utterly new apparently seemed to them the best way of making their claim valid and obvious. As assorted governmental agencies later entered the business of providing support for schooling, they followed the lead of the foundations. Innovation was the magic word.

Whatever may be the correct judgment about possible overemphasis on innovation, the current desire for it is wholly understandable. Everything in our physical, social, and mental landscapes has appeared to be shifting drastically with increasing rapidity. Existing institutions, accepted principles, and established modes of thought and action have seemed incapable of coping with the mounting pile of complex problems besetting all sectors of our personal and social lives. Since schools are an obvious possible means for coping with social problems, drastic new educational measures have seemed to be called for, and gambling on the novel, even at long odds, has seemed justified.

We should not forget that it was essentially these same feelings that led to the educational innovations of the nineteenth century. The educators of that period too faced the problems arising from urbanization, industrialization, urban slums, juvenile delinquency, migrant populations, non-English speaking children, and the rest. Although their versions of these problems may seem to us puny in contrast to ours, at least similar sorts of pressures produced a similar interest in innovation.

If innovation is to remain our way of educational life, then we would probably do well to study the process and to learn what we can from past experience. By and large we have failed to do so. Many of our alleged novelties of recent decades have in fact been only reruns, with new terminology and new rhetoric, of ideas and practices of some earlier period -- re-inventions of the wheel. But because those employing these novelties either did not know about these the earlier history of their "invention" or else did not care, these advocates have proceeded as if the situation were novel. They have failed to inquire what had earlier proved to be strong points that should now be maximized or weaknesses that should be fenced against. Most important they have failed to ask why it was that the original version had dropped so far from sight and mind that their own "discoveries" seemed to them something utterly new. These events have given considerable plausibility to Santayana's dictum that those who do not know history are condemned to repeat it. Examination of these four innovative movements, then, should enable us to learn something about the process of innovation itself and perhaps to profit from this knowledge.

**The Nature of Movements**

Since the term "movement" will appear with great frequency in the following pages, a preliminary comment about its meaning is in order. It must remain what was once called a "vague concept" simply because the phenomena to which it refers are so ill-defined in structure. Contrasting "movement" with "organization" is enlightening to a degree. Organizations possess a formal structure. They have constitutions and bylaws. They have elected officers and governing boards. The line between membership and non-membership is usually sharply drawn by the necessities of application for membership, the payment of dues, the meeting of requirements for membership, the possibility or the necessity of resignation upon withdrawal, or other formal procedures. Organizations usually have regular meetings, a journal, and some sort of central office. Movements usually give rise to one or more organizations and thus acquire in part some of these structural features. But movements as movements are of quite a different sort and sprawl around and beyond any organizations they generate.

The relatively clear structure of organizations had made possible various descriptions and theories concerning their birth, growth, and dissolution. The amorphous movement provides no such solid basis for comparable effort. The dates of a movement's birth and death are always so vague as to be unspecifiable. Its waxing and waning can be gauged only by the use of indirect indices of various kinds. The leaders are self-appointed and may not know they are actually leading movements until their movement is well under way. The outer edges are completely undefined, with the distinction between "adherent" and "non-adherent" to a movement being hazy at best, and hence a movement's actual size is unknowable. In fact a movement seems to exist only insofar as others refer to some vague group of people sharing certain general beliefs and activities as a "movement," but who or what is meant by any such reference may vary widely from statement to statement.

In sum, the student of movements, by the mere act of studying them, continually runs the danger of making them appear more structured than they in fact are. But that there are phenomena in relation to which the word "movement" has meaning and that these phenomena come into being and pass away seem matters beyond dispute.

**The Problem of Slogan Systems**

Educational movements often form around some philosophy or slogan system. Ever-present questions are how accurately this set of ideas is diffused throughout the mass of the movement and what amount of dilution and distortion the ideas undergo in the process. In the case of our four examples where the original German thinkers are separated from their American followers by rather wide reaches of time, space and culture, the question can become acute.

Will and should a disciple transmit the views of his master without altering jot or tittle? Clearly the answer to this question will be "no" for a variety of reasons. First, even the master's **ipsissima verba** can hardly be regarded as a complete and immutable truth, to be ever after held in reverence. These philosophical or educational doctrines did not lay claim to divine inspiration or intuitive infallibility. Consequently the desire or claim of anyone to be able to improve a doctrine has a prima facie validity. And who better could make any appropriate changes than an alleged disciple and close student of the doctrine?

This epistemological argument, so to speak, is reenforced by psychological considerations. Merely to transmit intact the master's doctrine seems a rather servile sort of discipleship owed only to a god. The follower, to preserve his self-respect in his own eyes and those of his contemporaries, is under considerable pressure to "be his own man," to make his personal contribution to thought ad action in his field of endeavor, to leave his own mark on the doctrine he has espoused.

Yet if the integrity and validity of the original doctrine are necessarily this fragile, one may at least ask why later developments are customarily attached to some name like Hegel, Herbart, Dewey or Piaget. Probably one major reason is that the name is thought to confer a cachet of fame or excellence. The follower gains impressiveness from operating, however vaguely, under the aegis or auspices of a great name and presenting himself as having a famous forerunner and ally. In the terms of our current jargon, it is an attempt at legitimation. There are advantages in John Doe's being able to present his ideas, not as some mere personal revelation but as the product of a familiar and honored tradition.

The use of these labels also can serve to some extent as a sort of shorthand. If a man declares himself an Aristotelian or a Hegelian, from the single word we get at least some idea of his general stance just as we do in other fields when he announces himself a Freudian or a Keynesian. Up to a point, writers and speakers can save a considerable amount of time or space by not attempting to elaborate a complete position but by simply asking, through using the label, their readers or hearers to "take as read" a certain amount of some fairly familiar doctrine. As in all short hand transcription, however, this procedure can easily lead to confusion, for the question always is, "Exactly how much and what of Hegel is the disciple keeping unchanged and where is he departing from the original formulation?" Sometimes the precise answer to this question appears to be not too clear to the disciple himself.

Then too, changes in time, place and circumstance seem to justify -- even demand -- modifications in the original doctrine just as presumably Christianity had to be changed from the religion of Jesus to the religion of Paul if the Gospel was to be brought to the gentiles. Proponents and especially critics of the doctrines to be examined here were well aware of this sort of issue and question. Were doctrines developed in "despotic

Germany" appropriate for us in "democratic America"? Could songs and games, reflecting the life of pre-industrial, rural Germany, relate meaningfully to the experience of children in increasingly industrialized and urbanized America? Had educational theories and programs developed in the first half of the nineteenth century been rendered obsolete by the scientific advances of the last half? This last general topic of science included many assorted specific question. Did the programs provide sufficient time for the study of science now seen as so important? Were their psychological foundations "truly scientific by modern standards"? Did the concepts, methodologies, and demonstrations of the old theories meet the standards set for such matters by recent scientific developments?

In short, as even this brief and incomplete discussion of the general issue can at least suggest, there is no lack of good reasons for undertaking to alter philosophic and educational doctrines, and most followers feel little or no compunction about doing so. In fact, modification of any original promulgation seems so inevitable as scarcely to merit comment or consideration.

**The Pitfalls of Altering Doctrines**

Making changes in doctrines is, however, fraught with some peril as our historical examples will make evident. If the original doctrine is tightly coherent and close-knit, changes at one point have logical consequences elsewhere throughout the system. An altered principle may come into conflict or even contradiction with other principles; it will have implications and consequences in those subordinate parts of the doctrine derived from it. If these possibilities are not explored and the necessary adjustments made, the once coherent doctrine is pushed into incoherence and possibly self-contradiction. To effect changes in such a way as to avoid these difficulties requires an intelligence, a knowledge, a meticulousness, and a patience which frequently are not possessed by followers. That doctrines are garbled rather than improved is hardly surprising.

Another trap into which followers may fall is that they produce changes in the doctrine because of ignorance rather than intention. Reading and thinking require time and effort; many would-be reformers are loath to indulge in either. Better to act -- doing what one wants to do in any case -- and merely to snatch a slogan or two which can be quoted in order to claim discipleship.

A special problem arises in connection with several of the doctrines under discussion here. Those of Hegel, Herbart, and Froebel all originated in the first half of the nineteenth century when metaphysics was popular and important. For these men, metaphysics was not merely a major portion of their system of thought; they tended to see it as the foundation -- the portion which dictated to a considerable degree the structure and nature of the other parts. But by the close of the century, metaphysics was no

longer the lively and important field it had been in the heyday of Kant, Fichte, Schelling, Herbart, and Hegel. What is more, it was not merely unpopular; it was regarded as obsolete and antiscientific. To soft-pedal metaphysics was, consequently, an obvious bit of prudence. This tendency was further reenforced by what is often alluded to by phrases like "the pragmatic temper of the American mind." Consequently, the American followers of Hegel, Herbart, and Froebel were constrained to minimize, ignore, or deny the metaphysical component in their philosopher's system, and most of them did so. Yet when the very foundations of doctrine are ignored or denied, what validity can be claimed for the remnants of it beyond the dubious argument that the original thinker chanced to do a few right things for utterly wrong reasons?

**Conclusion**

The four movements studied here are historical events, and one of the purposes of this book is to present them as such, each interesting in its own right. But educational movements are more than merely historical phenomena of the distant past. A long line of educational movements have followed those examined here, giving rise to the same loyalties, enthusiasms, and animosities we shall see in our historical examples. Educational movements are with us now and will probably continue to be prominent features of the educational landscape throughout the foreseeable future. It would, therefore, seem appropriate to try to achieve a better understanding of these persistent educational phenomena. Consequently, a second purpose of this book is to see what generalizations about movements as a genus can be drawn from the examination of these four specific ones. How do movements come into being? How do they develop? Why do they die? What contribution, if any, does an educational movement make during its short life to the general advance of educational thought? Third, since popular educational innovations usually develop into educational movements, a better understanding of movements and their contributions should also yield insight into the probability of long-term impact from educational innovation. One need not believe that history repeats itself to suspect that the fates of current and future instances of educational innovation will not be totally different from those of these historical examples.

## Introduction: Factors in the Rise and Fall of Movements

In the preceding chapters we have looked in some detail at four educational movements, which introduced various sorts of innovation into American education. They were extremely different in nearly every respect; yet amid all this diversity there is some similarity, some general points apparently common to all educational movements in the sense of phases of their development and the reasons for these stages in their rise and fall. A glance at these as they appear in the varying contexts of the different movements will suggest some generalizations about educational movements.

There also remains the question of "So what?" When the tumult and the shouting have died, are the observable benefits to schooling and education in any way proportional to the enthusiasm and effort involved? What, if anything, of lasting value have all the lectures, articles, books, meetings, organizations and journals produced? Or do educational movements merely fade away into episodes occasionally exhumed by historians but leaving no mark for good or ill?

Educational movements can be viewed from at least four different perspectives: (a) that of the movement itself considered as a quasi-organism with a life-cycle of birth, growth, and decay, (b) the perspective of the doctrine on which the movement is based, especially its comprehensiveness, coherence, and the range and aptness of its applicability to education, (c) the viewpoint of the movement's leaders, and (d) the viewpoint of the followers or adherents. Most of the obvious phenomena appear in all the perspectives, but they gain somewhat sharper definition by being viewed from diverse vantage points. Even more important, the movement itself is the product of the interplay of all four of these components. For example, the leaders and the followers have very different motives and interests, but it is their interaction which gives the movement its life and shape, while simultaneously the nature of the doctrine and the specific stage in the movement's development at any given moment open certain possibilities for both these groups but close others.

## The Problematics of Leadership

Movements come into being, grow, and pass away. They do not arise spontaneously. A movement is born only because one or more skilled and vigorous entrepreneurs bring it to birth. Movements depend on leaders, and a leaderless movement seems an impossibility. Probably such leaders do not explicitly start to head a movement. They encounter something they think is good -- some new idea or fact, some new point of view, some new solution. The leader or leaders seek to share their discovery, and others become interested. The precise point at which leaders' evangelistic efforts succeed in interesting enough other people to generate what will be

called a movement is, of course, impossible to determine.

Once the movement is born, a symbiotic relation between it and its leaders develops and persists although the kinds of benefits and the direction of their flow change at different stages in the life-cycle of the movement. At the outset the leader or leaders generate and nourish the movement. Once the movement has gained certain bulk and momentum, however, there is some reversal in the flow of benefits, and the proponents begin to reap rewards. They gain status, for example, as officials in the movement's organizations or as editors of its publications. Now more members of the profession begin to wonder what the hubbub is about. To use the old figure common in the period studied here, educators want "to set their educational watches" -- primarily to keep them from running slow and thus proving their owners "behind the times." The result is a flood of further invitations to speak extended to the advocates, with the accompanying joys of increasing fame and larger as well as more frequent honoraria. "Dr. Q., the Xian," the spokesman for a new movement, is likely to be in greater demand and to have a clearer status than plain "Dr. Q."

The movement in its turn benefits from this increasing conspicuousness of its advocates. A bright and loud bandwagon which is obviously rolling with noise and speed attracts both spectators and would-be riders. If prominent educators are agitating for the doctrine (and the leaders by being leaders become prominent), it must have virtue, and members of the profession feel under some compulsion to participate at least to some extent. They listen and read; they join the movement's society or club. The movement grows.

This happy reciprocity between the movement and its proponents may continue for several decades. Then, as we have seen, decline may set in because the leaders cease to lead or at least cease to nurture the movement as they formerly did. This situation can arise from various causes. For one, the movement may have carried a leader into a new career, a position in which he has less time or interest to devote to the movement or fewer opportunities for forwarding it. Or possibly, once the movement has carried him to such eminence as he sought to reach, he has no further use for the movement as a career vehicle and abandons it. Possibly too, leaders may get tired of their causes. After years of saying and writing the same general thing on countless occasions, proponents may seek relief through propounding something new. Checks in the career of one or more of the movement's advocates also tend to redound ill favorably upon it. If these personifications of he movement become less visible and prestigious, so does the movement. Physical and mental illness of the advocate, his poor performance in some position, or the decline of the institution with which he is associated all diminish the movement as well as him. As will be more explicit in the later discussion of leaders, the preceding chapters offer examples of movements declining in part because of loss of leaders, or because of checks or set-backs in the leaders' career.

**Weaknesses of Novelty and Exaggeration**

Movements themselves also embody causes of their own decline. The greatest inherent strength of an educational movement lies in its novelty. It purports to offer new viewpoints, new procedures, new solutions to old and vexing problems. The leader, Dr. Q, is welcomed, not because he is about to assert the familiar educational verities (or, if you will, platitudes), but because he is presumably about to unlock the mysteries of some new idea -- "apperception," "the gifts," "genetic psychology," or some other novelty with which the members of the audience feel they should have at least a nodding acquaintance. But after one has heard Dr. Q a half-dozen times, has read several of his articles, and perhaps has even read one of his books, the gloss of novelty is off. The ideas and practices have become familiar or even stale. Nothing can remain a novelty forever. "So, what's new?" Insofar as novelty was the cause of interest (and certainly it plays a major role in the rise and spread of any movement), the established movement, as merely a rehearsal of the familiar, loses its charm, and both leaders and followers drift away from it.

A second inherent weakness of educational movements is the exaggeration connected with them. This excessiveness appears on several dimensions. One is the tendency to over-correction. In steering, the amateur driver or helmsman sees he is veering to the left and turns right; but turning too far, he yaws in that direction, until he again averts disaster by a sharp turn back to the left. A similar weaving motion is often perceptible in the succession of educational movements. Movement B, in correcting an obvious weakness, overemphasis, or neglect on the part of Movement A which preceded it, over-corrects. But soon the difficulties and dangers of this new tack become apparent, and Movement C arises to save the passengers. The hope, of course, always is that this tendency to weave is eventually overcome, and that the car, the boat, or education is put on its true course, with only minor correction. But as a common figure of speech makes clear, the educational motion tends to continue to be like that of a pendulum, swinging back and forth through its full arc. Possibly there is some fear that if the pendulum ever stopped, the educational works would whir to a halt. Or more probably the steady, straight course seems a little boring, and those who attempt to steer it appear a bit stodgy compared to those exuberant helmsmen who successively take over the wheel in the succession of education movements and make careers for themselves. We have a national addiction to fads. Insofar, then, as exaggeration of this sort is inherent in movements, they contain within themselves the source of their own ultimate destruction, for in the course of time the extent of their overcompensation becomes apparent and correction is made by the next popular movement.

Exaggeration also infects movements in the sense that they are usually oversold by the prime advocates, both to themselves and by them to the profession. The magic bullet is as much sought after by the public in education as in medicine. The drug firm that was compelled to limit the advertising of its product to a claim that it gave "transient relief to

superficial cases" must have ultimately sold its salve only to those who weren't listening or who didn't know the words. Because some lovable child has been to kindergarten, kindergarten is seen as the means for making all children lovable. Modest claims do not give rise to movements; they must be the way, the truth, and the light. Proponents of a movement, consequently, tend to become overenthusiastic about what they have found and to claim more virtue for it than it in fact possesses. The virtues it does have make it attractive, and other educators "join the movement." But with the passage of time, the extent to which claims outrun accomplishment becomes apparent, and disillusionment sets in, sometimes among the leaders but usually among the followers. Thus older members of the profession tend to look back and call a roll of movements that have had their day and ceased to be, bright hopes that vanished into disappointments.

**Problems with Doctrines**

When we turn to the "doctrines" on which educational movements are based, no particularly profound or complicated scrutiny is needed to observe certain facts about the nature of these doctrines and their applicability to education and to see how these factors hinder, limit, or facilitate the growth of the movements related to them. Simplicity and ease of transfer to the classroom situation, for example, are two obvious characteristics clearly prerequisite if the doctrine and its associated movement are to win much popularity among American teachers.

In our sample, Hegel's works were difficult and obscure. Even under the spur of Brokmeyer's enthusiasm and Harris's drive for self-improvement, the members of the St. Louis Philosophical Society found the going rough, and certainly their interest and their abilities were far, far above the average for American teachers generally. Harris in his own talks and articles directed to teachers generally used a very simple piece of Hegelian machinery involving the great "social institutions." But, to my knowledge, he never made this simplified Hegelian approach explicit to potential followers nor did he try to show how they could use this structure in their own thinking about education. To spread the doctrine among teachers Harris seems to have relied on Rosenkranz's Pädagogik als System. But this was no simple work even after Harris had expanded and clarified the translation and provided it with analytic outlines and very extended commentary.

But neither Rosenkranz's philosophical-historical text nor Harris's structure based on the theory of social institutions had very direct application to the daily problems of teaching. Rosenkranz was, especially in his comprehensive outlining and structuring of topics, a good guide for thinking about education at large. As a result, the book was a useful model for American professors of education to follow in preparing their own books on pedagogy. But for the narrower and more specific concerns of classroom teachers, who wanted help in teaching arithmetic or history, this embodiment of Hegelian doctrine offered little or nothing. It is no wonder

that the number of adherents actually employing the doctrine was small.

Herbart's original doctrine, since it was embedded in an extensive philosophic system, was at best hard to handle, even for him. But the German Herbartians reduced that system, cutting away the metaphysics and the ethics and leaving only part of the psychology, essentially only that involved in the doctrine of apperception, and the Americans took over this abbreviated form. This much doctrine easily translated into the concentration centers, Rein's five steps of instruction, and the theory of the cultural epochs. Since this machinery was easily taught and easily learned, teachers could become theoretical "Herbartians" without too much thought and effort. Using these same few concepts as organizing principles, the leader of the movement prepared handbooks of practical pedagogy and produced materials for use in classrooms. Thus, even more simply, teachers could become practical Herbartians by using ready-made texts incorporating the doctrine.

Froebel's doctrine was obscure to say the least. Although it was the basis of the gifts, songs and games, these could lead an existence of their own, and kindergartners could utilize the materials and follow the procedures blindly without worrying much about the justification for them and without any clear grasp of the symbolic significance of the activities they were conducting. As a result, trainers of kindergartners could vary over an extremely wide range in respect to the attention they paid to Froebel's theory. But they did train hundreds of girls how to run a kindergarten, Froebelian or otherwise.

Judd was the American most closely related to both Wundt and to schooling. By his social psychology (which he took from Wundt) he sought to illumine the relation of culture and society to the whole educational enterprise. Empirical studies, conducted by him and his associates, did affect the preparation of classroom materials and teaching procedures at specific points; and his continual emphasis on the higher mental processes had significance for both teaching and evaluation. As head of a major department of education, he trained in these directions hundreds of graduate students both through his own efforts and those of the faculty he assembled.

Munsterberg was prepared to instruct teachers in genetic psychology and wrote a "general pedagogy" of what must have seemed to be an old-fashioned sort. Munsterberg's book sought to present a unified theory of education; but the conception of education, not as a unified field, but as a "bundle of disciplines" was gaining in favor. Consequently Munsterberg made little impact and had few followers.

Hall's non-Wundtian emphasis on child-study promoted a rather simple process rather than a doctrine, and by the time Hall was able to pull the assorted data together into some sort of theoretical structure that might guide schooling, teachers and educators generally had already lost interest in the activity. But the simple idea of collecting data about children

could be sold to teachers and could infiltrate the normal schools.

**The Fit of Doctrines with Practices**

The educational level involved and the degree to which the doctrine, on the one hand, fitted that level and, on the other, was limited to it influenced the success of the movements. German Herbartianism had emphasized the eight years of the **Volksschule** although Frick and others had utilized Herbartian ideas in the gymnasium. The American Herbartians were engaged in training teachers, primarily for elementary schools. The transfer of the program from the eight years of the **Volksschule** to the eight years of American elementary schooling was an easy fit, and the elementary school remained the educational level where the American Herbartians were most interested and most influential.

Hegel's influence in Prussia, exerted through Baron von Altenstein and Johannes Schultze, was probably most apparent in the **Allereiwissenschaft** (or "knowledge of all sorts of things") of the gymnasium. But the chief American proponent of Hegelianism in education, W.T. Harris, did not adopt the views of the German Hegelians but took a generally Hegelian position directly with the aid of Brokmeyer. Since his activities (particularly his duties as U.S. Commissioner of Education), brought him into contact with education at all levels from the kindergarten to the graduate school, he personally applied his Hegelianism across the entire educational spectrum. Rosenkranz's version, insofar as it was used as a text in normal schools, did not fit the elementary school in which the students there were being trained to teach.

Although Froebel had given some consideration to other stages in human life, his last work was largely confined to childhood (the kindergarten), and so was the effort of his American followers. There were, to be sure, some attempts to move some kindergarten ideas and methods upward into the elementary school; but for a variety of reasons this effort usually encountered resistance, and Froebel's American followers limited their activities to the kindergarten, a rather restricted range. The Education of Man and the Songs, although used in the training of kindergartners, did not precisely fit the educational level for which they were being readied.

Wundt's American students were attracted to Leipzig by the fame of his **Institut** for experimental psychology. Since at that period psychology was establishing itself as an independent field at American universities, most of them returned home to become university professors of psychology. Hence, Wundt's influence in America was primarily on psychology and then indirectly on education, particularly through the rise of mental testing and other applications of psychology to educational practices and programs. Hall and Judd, however, worked directly with all levels from the elementary grades to the graduate school.

To summarize the relation between the doctrines and their movements, Hegel's doctrine was too difficult and too remote from classroom activities to win much affection among American teachers. Herbart's and Froebel's theories would have presented many difficulties in their original form, but they were truncated and simplified and even their procedures and materials were still further detached from the remaining doctrine. As a result, through the "steps" and the "gifts," teachers could be Herbartians or Froebelians without having to worry much about a doctrine they did not understand and perhaps did not even know about. Since Wundt had no doctrine, his American students could make assorted contributions to education through such sub-movements as "genetic psychology," "the scientific approach" and "child-study."

**Interactions Between Leaders and Doctrines**

From the perspective of a leader, a mere common-sense analysis of what is necessarily involved if one is to start to develop an educational movement suggests a series of steps which a leader necessarily takes. Historically we have seen that the leaders of the movements examined here did take them. Furthermore, the skill, care, and good luck with which these steps were taken in each case had considerable effect on the size and persistence of that movement.

First, the leader must somehow learn about the doctrine. He can do this by studying directly with the master, through reading his works, or by acquiring it from earlier disciples. Wundt's followers were Wundt's own students. Although he cannot be said to have had an educational "doctrine" in the sense that the other ultimate sources of our movements did, his students could directly hear and see what he said, did, and wrote as an embodiment of his view of psychology. The masters revered by the other movements in America, however, were dead, sometimes long dead, before their American followers became aware of them, and direct contact was impossible.

Brokmeyer is the sole example in our group of one who learned the doctrine by reading the writings of the master. He wrestled bare-handed with the Hegelian texts without intermediaries or interpreters of any kind. His understanding was at least his own understanding.

The most common way is to acquire a doctrine from earlier disciples of the master. This was the method of all the St. Louis group insofar as they learned their Hegel from Brokmeyer. The American Herbartians studied with the German Herbartians. The American Froebelians worked with Froebel's widow, the Baroness von Marenholz-Bulow, Mrs. Kraus-Boelte, and others who had been directly associated with Froebel. The existence of intermediaries complicates, of course, the process of transition. By emphasis and de-emphasis, by choices of inclusion and exclusion, and by making "improvements" in the original doctrine, these intermediaries wrought varying amounts of change in it as it was transmitted to the Americans. To be sure, often these transmitters ultimately referred their students to the

writings of the master, which they made available in translations, but their initial influence may have biased all such later reading of the original sources as was done by the followers.

Once the leader has acquired the doctrine, he must spread it. He must announce its general characteristics and proclaim the blessings it will bring. Since the net for converts must be cast wide and as many believers as possible caught, it is no coincidence that leaders of educational movements soon acquire large bibliographies and long lists of public appearances. At this stage all the American movements had proponents who were tireless in spreading their messages.

After this propaganda has been disseminated and after interest and even adherence have been aroused, the leader must shift the tenor of his speeches and articles. If members of the audience have become interested in adopting Hegelianism or the like, how do they go about it? The leader's writings must now take a how-to-do-it turn. How can the new convert utilize the doctrine in curricula, lesson plans, and day-to-day activities?

Instruction of this sort is necessarily more complicated and detailed than the mere description of the new movement and its possible contributions. In fact, the burden of instruction is usually too great for the single speech or article to carry. To be instructed adequately, the audience must read or listen longer and harder than that informal, isolated exposure, which may suffice to arouse initial interest or enthusiasm. "One easy lesson" is scarcely sufficient to make a competent practitioner of any doctrine however simplified. Guide-books can help, but the new convert may read them carelessly or misunderstand them. Fairly prolonged, direct contact is needed. From this fact springs the desirability of "having students."

**Leader, Doctrines, and Followers**

"Student" in that phrase implies a close, formal relation and the learner's personal or professional commitment to do more than listen or read casually for an hour or so. As we have seen, the failure of Harris to seek and acquire "students" in this sense was one reason for the narrow and short-lived spread of Hegelianism. Snider sought to do better through his "people's universities" and kindergarten classes, but he devoted these efforts more to instruction in his "literary Bibles" and his psychology than to Hegel. The Herbartians found their students chiefly in the normal schools, and these were formal students. This point of entry gave the Herbartians adequate access to one of the main streams of teachers in American education at the time and accounts for the fact that teachers in training were reared as "Herbartians" for a full quarter-century after the movement had lost its major thrust. Unfortunately for the Herbartians, during this period the normal school lost its influential role in education to the universities with their recently established chairs of pedagogy and psychology. Thus the Herbartians succeeded at one level, but not the most

effective one. Froebel's disciples excelled in their activity in training teachers, and the longevity of the kindergarten movement with its greater or less departures from Froebel's doctrines is due in large part to the fact that hundreds of young women were annually inducted into the mysteries of how to conduct a kindergarten. Enterprising publishers packaged the gifts and other kindergarten materials, which thus became easily available to any kindergartner who wished to use them, whether with or without Froebel's theory. Wundt had graduate students, and they, in their turn, had graduate students, who also took over positions in universities. As the influence of the university on all levels of education increased, so did the influence of Wundt's students.

Certain other instrumentalities also can aid this didactic effort to instruct converts in the doctrine. A journal for the group can give much more extended and repeated instruction in the doctrine than can scattered and occasional articles. The Journal of Speculative Philosophy was read by the intellectuals and the would-be intellectuals but it reached few teachers, and the Hegelians' lack of a distinctly pedagogical journal probably accounts for some of their failure to penetrate the American classroom. The Kindergarten Messenger and its successors and Hall's Pedagogical Seminary served this purpose for those cults. The Herbartians used their Society with its Yearbooks and its annual meetings to this end.

But teachers continually feel themselves overburdened and overworked. Consequently, they always prefer to get their educational materials ready-made rather than have to expend the time and energy necessary to produce them for themselves. Hence the clever advocate of a new movement is likely to turn out texts and other teaching materials which the busy teacher can take directly into the classroom and, simply by using them, follow the principles of the movement. In this regard the performance of the Herbartians was outstanding. For grade after grade and subject after subject, they (particularly Charles McMurry) turned out texts, lesson plans, reading lists, source materials and all the other items needed by a novice practicing Herbartian. The kindergarten ladies were only a little, if any, behind the Herbartians in producing the needed materials. Once more, the Hegelians were from this point of view remiss in that they did not prepare materials which the teacher could take into the classroom and utilize with minimal effort. Hall met this criterion when he distributed his own child-study questionnaires for teachers to use with their pupils; but by and large, the Wundtians limited their efforts to instructing the classroom teacher rather than preparing materials for her use.

**Leadership in Declining Movements**

As movements wind down -- as we have seen ours do -- the leaders find themselves in a new position somewhat akin to that of the captain of a sinking ship. Are they to preside over the dissolution of the movement which they initiated? The most happy fate is possibly that exemplified by Harris. Although by the start of the twentieth century, his movement had

essentially shrunk to be only he, his magisterial position in education allowed him to hold with dignity the same ground he had occupied for forty years or more. Similarly, age and status allowed Elizabeth Peabody to continue to play her accustomed role and hold to her old views amid the changing kindergarten movement.

Tragic, but perhaps heroic, are those who go down with their colors nailed to the mast. Thus Hall, five to ten years after child-study had run its course, still felt compelled to extol its past accomplishments and current efficacy before he belatedly retreated to his earlier love, psychology. Similarly Susan Blow continued to the end of her life to be the staunch defender of her interpretation of Froebel's principles and materials long after the general kindergarten movement had, rightly or wrongly, either directly denied Froebel's ideas and practices or else buried them as a small portion amid a mass of alien items. In consequence she acquired the label of reactionary.

For the most part, however, leaders extricate themselves from the fate of their movements as gracefully as they can. That terminology is doubtless somewhat unfair to Snider, who regarded his new psychology, not as a repudiation of his earlier Hegelian philosophy, but as its inevitable next "moment." Similarly Judd saw himself as holding fast to certain of Wundt's major ideas but otherwise as participating in the general extension of those developing sciences, psychology and education. These two, then, believed that the movements with which they were associated developed into new forms rather than died.

Van Liew first tied his Herbartianism to a new movement, child study, and then withdrew to a college presidency. DeGarmo also took a presidency but returned to join Charles McMurry in assisting in the disappearance of the National Herbart Society into the National Society for the Study of Education. Frank McMurry, the youngest of the Herbartians, could only look back on the movement as one of a number which had promised much but failed to meet expectations. For Munsterberg, education was merely one of the possible areas of application for psychology. As he found no great welcome there and as other fields proved of equal or greater interest, he simply stopped working in education.

The preceding analysis is neither novel nor profound. Its virtues are merely that it puts into sharp relief the diverse ways in which leaders of four educational movements contemporary with each other accomplished what are apparently necessary tasks in such an undertaking and that it suggests how differences in the ways in which these steps were taken affected the sort of clientele gained, as well as the strength and the longevity of each movement.

**Characteristics of Followers**

Movements have not only leaders but followers as well. Although we

are generally well informed about the ideas and activities of the leaders and may often feel we can impute motives and purposes to them with a fair degree of accuracy, the thoughts, feelings, behaviors, and motives of the followers necessarily remain obscure, lighted only occasionally by some comment or incident known to us. Statements about followers are, consequently, so conjectural as to be almost fictional. Nonetheless, we have a few bits of evidence as well as some vague clues and guesses as to why people "join" educational movements -- that is, why they attend the meetings, buy the books, subscribe to the journals, and do all those other things involved in being an adherent.

At the lowest level, followership may help to satisfy in part a variety of personal needs and interests which have little to do with the movement or with education. The sort of thing involved can be at least suggested by the old joke from the early days of the Great-Books movement. When a girl was asked why she had enrolled she replied, "Well, it's better than bowling, and I don't like to sit at home on Monday night." Similarly, the Concord School of Philosophy never moved to the area furnishing many of its students and faculty simply because torrid St. Louis was a much less attractive place to spend part of one's summer vacation than was Concord. Certainly, passing time pleasantly, developing some intellectual interest, making new friends, finding a mate, and a plethora of other personal interests can be served to some degree by participating in educational movements. Some followers may actually have little more than this sort of interest. But these concerns have little if any relation to the actual characteristics of the particular movement; almost anything would serve equally well. Those whose interests are only at this level seem unlikely to become devoted adherents for any length of time.

Other motives are more professional and more directly related to education. The urge may be nothing more than the wish to reassure oneself and one's superiors that one is active in the forefront of one's profession, that one is in on the know. This sort of interest, however, may lead the teacher to follow each new development rather than loyally to support a single one.

Relatively few of those joining any educational movement want some grand perspective from which to view education broadly or in its relation to other activities. Those few who do are generally professors who seek some general matrix useful in preparing their own books and articles. Classroom teachers and others who necessarily constitute the bulk of most movements want something more particular and more immediately applicable. The Herbartian steps are a prime example of such useful bits. But once a few of these handy devices or useful classroom materials have been acquired, the follower tends to feel that he has got what he wanted (or all there was to get) from the movement, and he begins to lose interest. This tendency accounts in part at least for the short life of movements.

But there may be a degree of professional motivation beyond this. Certain nagging problems infect the daily life of all those involved in

schooling: discipline, the failing student, the student who is slow to learn, and a host of other perennials. Then too, a certain proportion of educators (and one always hopes it is a large proportion) is not self-complaisant. These teachers continually ask themselves how they can teach better. "If I used other procedures or methods, could I do a better job?" "Am I using the best materials?" "Do I know as much as I could and should about my students?" "Have I organized the course properly?" "Is it part of the right total curriculum?" "Am I aiming at the right outcomes?" Questions like these, even if they are not framed so explicitly or self-consciously, tend properly to haunt all those engaged in schooling. As a result, some followers look to educational innovations for help in solving one or more problems of this sort. Possibly the most satisfied adherents to movements in general are those who feel that they have got help in some form (new insights, new perspective, new modes of attack, new materials) in solving a problem which has bothered them.

The number and variety of the problems endemic in schooling, however, leads the follower to hope that the movement offers a panacea for all or most of these ills, and the enthusiasm of the leaders and their desire to acquire as many adherents as possible causes them to oversell the product. Yet, such is the human condition, instant miracles of this sort are impossible, and extravagant hopes are doomed to disappointment. The disillusioned follower may then drop out and adopt a cynical view toward all other educational innovations, or may hopefully run after every successive innovation in search of some other cure-all.

Greater personal involvement seems likely to produce greater and more prolonged participation. The continuing popularity of child-study was probably due in large part to the fact that the activity of its general membership was not limited merely to reading or listening to expositions of the doctrine or to adopting some procedures or materials approved by it; members could actually "study" children themselves and have the feeling that their findings contributed to the funded wisdom of the movement. The kindergartners, with some practice-teaching and with the knowledge that presumably they would soon be conducting their own kindergartens, probably had an even higher level of prolonged personal involvement.

If the enthusiasm and activity of leaders waxes and wanes -- as it does -- certainly the interest and participation of followers exhibits similar variation. The few most enthusiastic followers may move upward to leadership roles. But most followers drift into and out of movements quietly, with even the more enthusiastic leaving little trace other than perhaps their names on membership rolls or a society or a subscription list for a journal. At best, educational movements are amorphous entities, and their outer edges are as ill-defined as are the points of their birth and death.

The history of education is strewn with the corpses of educational movements. But beyond serving as career ladders for the leaders and affording some intellectual and professional stimulus for the followers, what does the long series of movements contribute? Accepted wisdom answers that the good things in each movement, cleansed of what is faddish, exaggerated, or mistaken, are added to the total store of educational knowledge or thought. Just as in the succession of ocean waves each one, before it disintegrates, leaves a few grains of sand on the shore, so each movement is thought to deposit some residue of educational wisdom.

This response appears quite questionable under closer scrutiny. Educational doctrines seem almost "writ in water." A decade or two after the height of their popularity it is difficult to discern any definite item of thought or action clearly attributable to them. If isolated elements can indeed be found, they seem a very thin outcome from the scores of books and the hundreds and even thousands of speeches and articles generated by each movement. Such a consequence seems to demand some attempt at explanation even if only of a most speculative sort.

**Societal Change**

At this juncture two points that might give rise to misunderstanding require at least brief clarification. First, to emphasize the minuteness of the long-term influence of educational movements may seem to imply that schools and schooling have never changed. That would suggest, in the terms of the recent national bicentennial, that the schools of 1976 were like those of 1876 as well as even those of 1776. Such, obviously, is not the case. For example, the modern school building does not resemble its factorylike predecessor of the 1890's any more than that looked like the little red schoolhouse and its precursors. But then, the modern factory with its bright colors, fancy fenestration, and lavishly landscaped site does not resemble its 1890 version either. And domestic architecture too has changed as drastically.

To be sure, school architecture was affected by changing educational ideas of grouping, scheduling, teaching, and curriculum; and changing concepts in those regards have already rendered parts of relatively recent structures obsolete. But the causes of these shifts in architectural styles like other matters relevant to schools and schooling are so numerous and heterogeneous that commonly we label them simply "changes in lifestyles" or something of the sort. Fads, fashions, changing conceptions of the good life, of the good society, and of good taste, economic and political factors, and a host of other forces are involved. At any given time this vague "spirit of the age" has many assorted components.

In these changing American lifestyles, a conspicuous and partly causative factor and one which has influenced education has been the developing technology. As photography, the phonograph, the talking picture, the magnetic tape, TV, and the computer (to name only a small

sample) have appeared on the scene, some educators have seen them as potentially useful tools and have tried them out, sometimes at the urging of those manufacturing and vending such equipment. These technological innovations then give rise to phenomena very similar to those we have seen associated with educational movements although they are rarely, if ever, labeled such. Leaders work up interest and enthusiasm among their colleagues and make careers spreading the word. Lured by novelty and large claims, adherents develop. Teachers, sometimes at the urging or orders of their superiors, often adopt these tools in a rather mindless way, having felt no need for them and having no clear view of those ends to which they are means. As we saw in regard to Froebel's gifts and occupations, apparatus and the procedures related to it can lead a rather separate existence and can be employed in a purely mechanical fashion. Then as novelty wears off or as pressure to be in the forefront eases, the idle language laboratories or the mute and dark TV installations bear witness that education fashion has change.

In sum, many general societal factors are operative and affect schooling. Especially relevant here are such matters as the beliefs which are current concerning the family, children and childrearing, the value attributed to learning, the definition of personal satisfaction and personal success, the point viewed as the proper balance between individual freedom and social responsibility or personal isolation as opposed to social involvement.

Received opinions and attitudes concerning these matters are products of a wide variety of causes, and they change over time. They leave their mark on schools and schooling, but those effects are not usually the fruit of educational thought or theory. In fact, stemming from many different sources, the general form these assume at a particular time is not the consequence of any conscious deliberation; as we sometimes say, they are "what is in the air." To casual inspection at least, they appear more potent than educational movements or educational conceptions in altering schools. As we ave seen, educational movements come into being and develop in part because they are consonant with these societal forces and become obsolete when these elements shift.

**Possible Biases**

A second matter also requires clarification. It may appear that the innovative movements studied here represent a biased sample and thus constitute an inadequate base for generalization about innovation. Specifically, three of the four movements examined here, those of Hegel, Herbart, and Froebel, were based on that philosopher's metaphysics. Consequently, an argument might run, it was inevitable that, as metaphysics fell into disrepute, the total doctrine including the educational parts should become untenable and be able to survive only in bits and pieces. This interpretation might also seem to suggest further that if the innovations studied had been based on more "enlightened" and "modern"

philosophic principles, the results would have been and, in the case of later innovations, will be different.

A little reflection will at least suggest that this view is less plausible than it may appear at first glance. Members of each human generation have an Hegelian tendency to believe that the World Spirit has reached its full flowering in their epoch, that they possess the ultimate insights into truth and goodness. Consequently, we look back with some condescension on our predecessors. Yet, as recent history suggests, our current views, although they may rest on psychological, political, moral or other sorts of principles rather then strictly metaphysical ones, are almost certain to be superseded, and any educational theories and practices we base upon them will be rendered obsolete in the eyes of later generations. That the foundations of three of our doctrines, therefore, were metaphysical was an accidental rather than essential element in their fates.

A brief additional example may help elucidate the point. Historically John Dewey was probably the next major source of educational innovation after our four instances and was the leader of an education movement. Early in his career he renounced the Hegelianism which he had originally adopted, and throughout the rest of his long and productive life he advocated his "experimentalism" with its foundations in scientific method and inquiry. Yet in recent decades Dewey's position has been belittled. His theory of experience has been charged with being "metaphysical"; his psychology has been seen as deficient in that it gives too little attention to the unconscious; his hope that problems involving political and moral values would yield to scientific inquiry have been deemed vain. As a result, some of his educational principles have been judged unrealistic or just wrong. Precisely, how much of Dewey's educational innovation can now be found in our schools and schooling is certainly an inquiry not to be embarked upon here, but it seems unlikely that the residue would be very great.

**Movements as Slogan Systems**

But to return to our problem of why educational movements make so little longterm impact, we can make a beginning by following the lead of Komisar and McClellan, who have suggested that "educational philosophies" be regarded as slogan systems.[1] Slogans are, of course, ubiquitous in education. Like the slogans of political platforms ("Balance the budget." "Fight inflation." "Stop tax loopholes"), they are vaguely general as well as systematically and intentionally ambiguous. These seem like "nice ideas" -- until I find out how the government plans to stop tax loopholes and learn that one of those to be plugged is one of <u>my</u> loopholes. As a result, political, educational and other slogans are often left at the general level and their usage is purely ceremonial -- evoking warm feelings in us because they suggest something that appears admirable and sensible. Thus "Love the child," "Arouse interest," "Understand the student," "Use

natural (or logical) procedures," "Reward good performance" and all the rest necessarily strike the educator as eminently desirable things to do. Slogans can even be tossed together in a pot-pourri and served up, as, for example, in what used to the be known as "Fourth-of-July oratory." Education always has had, and still has, such rhetorical concoctions.

But as Komisar and McClellan suggest, slogans can be developed into relatively tighter structures. More precise definitions can be offered, inferences can be drawn, some logical coherence can be achieved, and those other tasks done which will weave the parts into something resembling a unified whole, into a slogan system. Traditional "philosophies of education" can be viewed as the obvious examples of such slogan systems, with the doctrines of Hegel, Herbart, and Froebel as typical.

Let us return to some of the previous examples of bare slogans. "Teachers, love your pupils" has been with us for a long time. But in that bare form it is only an empty pious admonition even if uttered with the best of intentions. Becoming part of a slogan system, however, it gets fleshed out by other propositions which probably indicate such things as why teachers should love their pupils, what precisely is involved in loving a pupil, how such love can best be shown and bestowed, and how much an attitude or such behavior on the teacher's part affects the pupil's learning.

Or let us take another example, "Teaching should be done in accord with the child's nature" or "in a natural way." This admonition to "follow Nature's lead" seems impeccable good sense. Teaching and learning require effort enough in the best circumstances; to add more difficulty by working against the grain of nature would seem a certain invitation to disaster. Hence over the centuries nearly every educator has made "following Nature" a major justification for his suggested procedures. Comenius, Pestalozzi, Rousseau, Dewey, and Piaget (to take a very small and random sample of those who assert some variant of the general slogan) have, however, built it into quite different sets of other propositions. As a result, we customarily say that each of them "means" something quite different by "Nature" or "the child's nature"' and their educational prescriptions written in accord with that principle are equally varied. To be sure, adherence to the bare slogan may seem to mark off these educators from others who follow apparently contradictory or near-contradictory slogans in that they want to eradicate or change the child's nature (e.g., those who see child nature as depraved or who have little esteem for it on the ground that it is "particular" rather than "universal"). But the discussion still pivots on "nature." For example, if "child nature" is depraved because of the Fall, the effort of education is to bring him back to his "true nature" -- as created in the image of God, a little lower than the angels.

In short, a bare slogan usually cannot perform the minimal but important conceptual function of defining a class by serving as the criterion for inclusion or exclusion of those who accept or reject it. Perhaps propositions like "All educators urge teachers to love their

pupils" and "All educators recommend following natural procedures" are not valid universal propositions, but they come very close to it as isolated statements. Who would deny them? And that is, of course, the reason for their popularity. Only when these bare slogans are linked with other propositions in a slogan system do they require sufficient specificity to make assent or denial possible.

When, as we have seen, disciples rebuild some of the master's slogans or slogan-sets into their own new slogan systems, the meanings of the components of the original slogan system are vastly altered. Thus, to take an example we have already seen, the Herbartians, both German and American, were fond of repeating some half-dozen of Herbart's statements about the importance of controlling the presentations and building a proper circle of thought. But if the presentations no longer build the desires and the will as he thought but are, according to DeGarmo, themselves determined by the will, which presumably has some other origin, the quotations have a very different meaning; in fact they become meaningless.

DeGarmo apparently made this shift on the ground that the view of the priority of the will over the ideas was the more "modern," the more "correct" one. One might expect, or at least hope, that DeGarmo would then undertake to make the other necessary adjustments in the slogan system by accounting for the will through some other Herbartian machinery and by making those corrections in other parts of the system which would seem inevitable consequences of such a major alteration in this important principle. But DeGarmo made no such an attempt. To be sure, by that date he and the other major Herbartians had apparently lost interest in Herbartianism.

But this sort of behavior is not a personal failing of DeGarmo's or the Herbartians. Slogan systems are rarely developed. They are tinkered with. Some more or less extensive change is made to obviate some immediate difficulty, to solve some specific problem or to fit some particular situation. But these alterations are made with little concern for the consequences they have for the logic of the rest of the system. If the original system was relatively close-knit, major changes must destroy that original coherence.

Even in the course of time educational slogan systems are not reworked; they are dropped. Yesterday Herbart, today Dewey, Tomorrow Freire. They are often patched and twisted before the resulting shambles is discarded. If this mode of proceeding is followed -- and it certainly appears to have been the prevailing one in recent centuries -- it is hard to see how the succession of slogan systems can add to the store of educational wisdom.

**Consequences of Slogan Systems for Education**

This state of affairs has several very familiar consequences. One is

that educational procedures and routines survive much better than the conceptual structures originally associated with them. One reason for this fact is that procedures and routines require minimal conceptual support. They can be carried on merely by habit or tradition, by virtue of their pleasantness for pupils or teachers, or because they seem plausible as "educational" in some vague sense on the basis of some bare slogan. Or, another reason is that they can fit into and hence may be justified by a wide variety of other more or less logically coherent slogan systems. Consequently, as we have seen, the Herbartian steps and Froebel's gifts and occupations long outlived the systems of Herbart and Froebel, with their original purpose and function in those systems forgotten or denied.

A second familiar consequence of the tendency to abandon slogan systems rather than revise them adequately appears in the extent to which many innovations are merely the re-invention of some educational wheel. Because previous slogan systems drop so completely and utterly from mind and view, parts of them or their associated procedures easily appear to be genuine novelties to those who rediscover them. The discontinuity makes them discoveries, not developments, and their inventors and the educational public that accepts them see them as new revelations. As a result, no effort is made to profit from the experience with them gained on previous "discoveries" of them, and each time everyone begins to make mistakes from scratch.

A third consequence is that educational theory insofar as it is equivalent with these slogan systems or at least similar to them does not advance by accretion but by a long succession of fresh starts. Each system-builder seeks to incorporate into his conceptual structure what he regards as valid propositions put in their proper relations. But unless he is infallible, certain points are sure to need correction, and these changes demand further alterations for fine-tuning in the coherence of the system. But this further process rarely occurs. It is off with the old, on with the new.

In the face of this difficulty, many workers in recent years have attempted to ignore educational theory, or at least to minimize it, and to hurl themselves into the assemblage of empirical facts. (We have seen Judd as an early example of this trend.) The caricature of this position is personified in the contemporary graduate student with huge piles of computer printout, who hopes that somehow all these numbers will organize themselves into a dissertation problem and its solution with no help from the student. But even more serious and more sophisticated undertakings along these general lines ultimately come up against two well-known problems.

One is whether there are indeed "facts" that are completely "theory-free" or whether facts are necessarily theory-bound by the processes of inquiry, of validation, of terminology, and other theory-related elements that are required to establish any fact as "a fact." The second problem is the old Whewell-Mill controversy of the

nineteenth century: even if there are self-subsistent (theory-free) facts, are the relations between them equally "out there," or is theory required to relate these independent, isolated facts -- if such there be. Both these problems are complicated, and the present chapter is an inappropriate place to begin to explore them. They may perhaps suggest why, despite the vast amount of "educational research" carried on in the last half-century, the fund of demonstrated and generally accepted educational knowledge is so relatively light.

In the past twenty years or so, however, there have been numerous assertions that "educational philosophies" or "slogan systems" or whatever we choose to call them cannot take the shape and perform for education the functions which scientific theory does in its domain. There are many good grounds for this claim. One is the enormously wide spread of the educational field. Consequently, just as "Education" is often seen, not as a unified field of study, but as a "bundle of disciplines" (psychology, sociology, economics, etc.), so the view is sometimes held that educational theory should be a bundle of theories taken from its component fields.

Yet clearly such a "bundle" can hardly be coherent for several reasons. For one, education finds within each of its component "disciplines" competing and even contradictory "scientific" theories (e.g., those concerning learning, personality growth, cognitive development -- to name merely a few examples within the single general area of psychology). Differing choices made among these elements will produce very different educational bundles. In the second place, the basic principles generating the theories for each separate discipline are heterogeneous and not easily articulated into a single general set. In addition, a comprehensive educational theory must necessarily encompass the dimension of value -- something for which scientific theory need have only minimal regard. It seems impossible to talk very meaningfully or profoundly about education or schooling without taking account of the variety of human wishes, choices, purposes, goals, and aspirations in something more than the purely descriptive mode. As a consequence of these complications, to achieve a conceptual structure even faintly resembling a total educational theory would be an enormous and extremely complicated task. As Schwab has suggested in his work on "the practical," the operation may not be a theoretical or scientific one at all, but rather the employment of the practical "arts" of deliberation.[2]

In any event, here is not the place to begin a discussion of the actual or possible structure of "adequate educational theory" or the possible means of attaining it. But this cursory glance at its problems and complexities may suggest one possible way of viewing the slogan systems of educational movements.

**Functions of Slogan Systems**

As the persistent talk about the "whole child," the "total community,"

the "fund of knowledge," "educational policy," and the like makes plain, education and schooling are always under heavy pressure to take some larger (and hence more complex and more ill-defined) field of inquiry and to develop some ideas about it. Fragments may not suffice. Humpty Dumpty may have to be put together. Hence it may be useful to view educational slogan systems as rough-and-ready attempts to achieve a theoretical synthesis of sorts, as quick-and-dirty distant approximations to an adequate theory. That we have had and continue to have a constant succession of these efforts suggests that they fulfill some need and serve some purpose. Perhaps they are seen as surrogates for some adequate total theory.

Up to a point their "philosophies" present a set of propositions constituting a conceptual framework that guides and justifies a related set of practical operations. This function is one performed by theory generally. But if these slogan systems are attempts at theory, why is each one abandoned after a relatively brief period and a new one put in its place rather than being continually modified over time as is the case with scientific theories?

Some speculative answers to that question seems fairly well grounded in the historical record. One fundamental fact appears to be that in American education there has been very little market for educational theory. During the historical period covered by our movements the editors of educational journals almost unanimously lamented at frequent intervals the intense myopic concentration of American teachers on what they regarded as "practical" in an extremely restricted interpretation of that word. The editors, realizing the very limited general educations of the teachers of the time, sought to widen intellectual horizons a bit. They printed explanations of scientific facts and theories, biographies and criticism dealing with literature, expositions of educational doctrines, past and present, and other broadly educational materials. These efforts always called forth protest from many subscribers who demanded that the space be devoted to more "practical," "useful," and "helpful" content. They were ready to specify what they wanted: course outlines for the various subjects at the various levels, preferably accompanied by daily lesson plans, examination questions, materials for special programs for the national and religious holidays, games, puzzles, and tricky questions. They had no interest in why these materials were organized and taught in this fashion or why thy were used at all.

This concentration on what is immediately useful is not a failing merely of nineteenth-century educators. Friends and colleagues still report that presentations even mildly theoretical evoke the clear symptoms of glazed eyes and nodding heads. One of them recalls addressing a group of administrators and having the first question from the audience be, "What are we doing 'way out here on Cloud Nine?" Readers may search their own memories and recall how many popular educational books during their professional careers have been even slightly theoretical. No, precise theory is not a need felt by most American educators.

The suggestion advanced here is that educational movements, however ramshackle their theoretical portions, give the followers enough -- and possibly in their opinions more than enough -- theory. Leaders of educational movements too are not inclined to busy themselves with theoretical concerns for a number of reasons. Such presentations are not going to produce more invitations to speak or requests for further articles. Then too, the personality and intellectual bent of an educational leader are likely to be uncongenial with that kind of work. Harris, the best theoretician among our sample, led a movement which, apart from his own activities, was actually minuscule as far as schooling was concerned. DeGarmo, Charles McMurry, Hall, and Judd were more effective at recruiting followers but had little concern for theory.

As a result the slogan systems are initially treated rather cavalierly as the early leaders pick and choose what they will take of the original doctrine. Strong criticism of one or more of the slogans in the system frequently leads to their alteration or elimination, without any effort to make the necessary adjustments in the rest of the system. Then too, societal forces of the sort noted briefly above have probably rendered some of the old slogans unattractive and suggested new, more enticing ones. More shuffling of the slogans in the system then ensues. By this time, however, several things have happened. One is that the system has lost most of any coherence it ever possessed, and the substitution of new slogans and their related propositions for older ones has produced a result with little resemblance to the original doctrine. Equally important, the general slogan system has lost the original attractiveness -- its novelty. At this point no educator is likely to undertake the task of bringing order to the system as it now stands. Such an undertaking would appear an antiquarian operation in addition to being a very difficult one. Another discouraging feature is that the product of all this labor might not prove very attractive.

The easier move is to abandon the old system entirely and to start fresh with one whose slogans are "more in tune with the times" and claim to meet the present set of demands. Any relations this new system has with its predecessor are essentially coincidental and irrelevant although parts of old slogan systems may be incorporated in later ones after being fitted out with new packaging and labeling. We now have another innovation. Of course, in due time the newcomer will suffer the same fate and will be replaced by its successor, but no one is inclined to worry about that. As a result we have the succession of educational movements. Each has its day, then ceases to be, and, with the passage of time, any marks each leaves on educational thought, action, or materials rapidly loses its individual identity just as rocks grind each other down in a glacier. Thus the totality of educational thought and action does not appear as a neat structure built on the basis of experience as much as it resembles a terminal moraine. But at any given time some educational movement is reassuring a large group of American educators that they possess a "philosophy of education," a theory that justifies and explains much of their personal professional activity.

BIBLIOGRAPHY AND NOTES

**Acknowledgements**

Some of the topics treated in the following pages were addressed previously in articles in the History of Education Quarterly, the School Review, the Journal of The Midwest History of Education Society, and Padagogische Rudschau. Those discussions, however, have been completely reworked for purposes of the present volume.

Readers interested in reviewing some of the changing conceptions of what is important in education from the first half of this century can refer to my "Voices from the Past," the introduction to nine vintage articles in the 75th anniversary issue of the Elementary School Journal.

**Chapter 1: The Coming of German Innovation**

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## Chapter 12: The Life-Cycles and Contributions of Educational Movements

Several bodies of literature appear relevant to the phenomena discussed in this chapter, but actually they can be only suggestive rather than directly applicable. The first consists of the many studies of organizations and organizational structure and development. But, for reasons indicated in the text, movements, though they frequently give rise to organizations, are markedly different from organizations. Second, there is the literature bearing on the adoption of innovations, work pioneered by the agricultural economists. But there the innovations studied are specific and objective (e.g., the farmer does or does not use hybrid corn or practice contour plowing), and the motivations are economic in that adoption of improved practices is intended to yield a greater return. Both what is taken over by a follower of an educational movement and what benefits he derives from it are much more vague and of a different order. Third, there are the studies of the participation of adults in the activities of continuing education. Here the similarities are greater, and some of the categories used in this chapter are close to those suggested by my colleague, Cyril O. Houle, in his The Inquiring Mind (Madison, Wis.: Univerity of Wisconsin Press, 1961). Yet the facts concerning both participation and motivation and the inferences which can be drawn from them are much clearer in that area than in the case of the informal, amorphous educational movement. Finally, the analysis of Richard Pratte, Ideology and Education (New York: David McKay Co., 1977) suggests that ideology implies a stronger commitment to action than is chracteristic of the more casual educational movements.

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# SCIENCE, TECHNOLOGY, AND THE SECONDARY SCHOOL CURRICULUM IN THE TWENTIETH CENTURY

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## Introduction

The twentieth century has been a time of substantial social and economic change, the result in large part of the rapid growth and impact of science and technology. To what extent is it possible to see a corresponding cultural change manifesting itself through the medium of the educational system?

This essay is an effort to look broadly at the influence of science and technology on the culture of western societies by examining secondary education. In particular, it looks at the degree of success that ideas and practices in the teaching of science and technology had in recasting our views on an appropriate curriculum in secondary education, through which intellectual, expressive, and social development might be fostered. Culture is being used in somewhat the same sense in which Whitehead defined it in his essay on the aims of education: "Culture is activity of thought, and receptiveness to beauty and humane feeling."[1] In effect, it is a way of behaving in which the characteristic and definitive elements are cognitive style, sensitivity of taste and expression, and quality of human relationships.

In the early years of the century, secondary schools were largely concerned with transmitting to students the elements of a literary culture. In schools throughout most countries of the western world it was expressed through a preference for a study of the ancient classical languages which for centuries had been the traditional cultural vehicles. They provided an intellectual discipline for students as they strove to master the language and understand the thought; they could be used as models of expression; and they were a well-tried study of humanity providing specimens of human behaviour for criticism or imitation, and examples of powerful and creative human minds analysing political, social and philosophical problems with clarity and insight. But this kind of induction into a literary culture was already under attack. It had been questioned in the mid-nineteenth century, and by the beginning of the twentieth was being seriously challenged.

The German emperor Wilhelm II in 1890 let it be firmly known that "it is our duty to educate men to become young Germans, and not young Greeks and Romans."[2] The basis of secondary education accordingly, was not to be the classical languages but the German language. Similarly in another stronghold of the classical tradition, France, the secondary curriculum was modified in 1902 to enable students to achieve the traditional cultural objectives of a French education by alternate courses in which classical studies did not predominate or did not even exist. Henceforth the French language assumed a much more significant role in the curriculum, and the values of literary cultivation central to **la culture generale** were developed by a more intense and exacting study of French literature. In the United States, it was reported that, although 50% of high school students in 1899 were still studying some Latin, English by that time had "taken the fixed place of Latin in the old curriculum."[3] The situation

was similar in England where the study of English steadily became a central feature of the secondary school curriculum. As the movement for mass secondary education grew during the twentieth century the importance of indigenous languages increased, and in most countries it was through their influence that the literary tradition was successfully maintained.

There was, however, a second and more fundamental challenger both to the position of the classics and to the whole literary tradition itself. This challenge came from science. It was not, as in the case of the vernacular languages, an effort to maintain the existing literary tradition but an attempt to redefine the culture and underpin it with a fundamentally different educational curriculum. Its advocates initially challenged the authority of the classics, then questioned the centrality of any language studies, and subsequently proposed to rethink the prevailing notions of a liberal education.

One of the principal themes of the history of education in the twentieth century has been the struggle for a cultural reassessment which would recognize the significance of science and technology as a major contributor to intellectual and social life and would ensure them a correspondingly central place in the school curriculum. The struggle has passed through several phases. The early years of the century before World War I were a time of great promise, enthusiastic argument, and modest achievement. The interwar period of the 1920's and 1930's was one of open rivalry between the advocates of rapidly developing, increasingly well-organized scientific disciplines and the convinced and ingenious defenders of a literary based general education. In the two decades following World War II the scientific advance accelerated, and with it the rate of acceptance of the importance of scientific education. Towards the end of the 1960's, however, disillusion set in. The prospect of living in a fundamentally scientific and technological culture appeared less inviting, and many shifted their interest to the social sciences. Their thinking retained a scientific edge but was directed to social concerns and often to the problems that the physical and biological sciences and associated technology may have caused for various societies. The most recent time has been one of active reconsideration. Thus, throughout the century we have moved from an initial period of promise, through struggle and accelerated progress to disillusion, and finally to a rethinking of the nature of our culture, to a reconsideration of the place of science in it, and to possible reconstruction of the foundations of our secondary school curricula.

**Promise**

Germany was the pacemaker during the early years of the twentieth century in science and technology, and the United States was not far behind. "In technical virtuosity and aggressive enterprise, this leap to hegemony, almost to monopoly, has no parallel," an American historian has written of the development of the chemical industry in Germany in those

years.[4] It was very much the same in the other technological areas newly developing in that period -- in steel production, in the use of the internal combustion engine, and in the construction of electrical generating plant. German leadership was seen by many industrialists and educators to be based on "technological excellence and rational organization."[5] In consequence, German industrial organizations, research facilities, and schools were constantly subject to inspection and study by parties of interested foreigners. The German example was used in other countries to argue the need for a greater recognition of the place of science and technology in contemporary society and for more attention to the teaching of science in schools and universities. A British parent summed up a growing reaction to the literary curriculum of English secondary schools when he wrote: "The modern world depends on science; ... I want my boy taught science, to compete with the Germans."[6]

While technological progress at that time was acknowledged to be significant, science was also entering a phenomenal period of development. Scientific knowledge was beginning the exponential rate of growth that has characterised it throughout the twentieth century. Significant qualitative changes were also taking place. Darwinism had established itself in scientific thinking and had steadily seeped into general public consciousness. Other changes too in other fields were of considerable significance. In particular, three new departures occurred about the turn of the century: the quantum theory, initiated by Planck in 1900 which led to productive research on the structure of the atom, the theory of relativity developed by Einstein in papers published in 1905 and 1915 which had a wide effect on scientific thinking, and an upsurge in biochemical and genetic research which revolutionized knowledge of the nature of living organisms. Developments such as these brought the work of scientists to the attention of the public in lively fashion and gave promise of further dynamic productivity.

It is not surprising that, in such an atmosphere of burgeoning technology and revolutionary scientific achievement, much thought was given to the place of science and technology in the culture of the new century and to the appropriate kind of education through which young persons might be inducted into the changing intellectual climate. When the question 'What is science?' was asked, two kinds of answers were generally given: (a) science is the study of what scientists have found out about the natural world; or (b) science is the method by which scientists work. The first answer was mainly concerned with knowledge, the second with skills and attitudes.

On the matter of scientific knowledge most writers and teachers had in mind a steadily accumulating body of facts emerging from an increasing number of laboratories in the physical, chemical, biological, and earth sciences. The knowledge was orderly and arranged systematically. In fact, for some, the characteristic of scientific knowledge was that it was systematically organized. It was a classification of information based on an analysis of systematic observations or experimentation. Taxonomic

botany and anatomy were the prime examples of that view. Most secondary school courses and textbooks were arranged to present in an orderly way an appropriate selection of accumulated scientific facts and laws.

Scientific knowledge, however, might be valued more for its possible application and less for its possible orderliness. Its relevance to practical life and to possible technological development was obviously of significance for a country's industrial and commercial growth. On the other hand, for many scientists their work was not designed for economic profit, but was done, as Poincare expressed it, because they delighted in it,[7] and because it simply contributed to the further development of science. The difference between pure and applied science was not always clear but it was a distinction which continued to exercise the minds of scientists and their financial supporters and sometimes produced somewhat mixed feelings. In England, for example, on an Oxford University broadsheet about 1914 a student recorded in verse his disdain for a student of the technologies that were developing at the new English provincial universities:

He gets degrees in making jam
At Liverpool and Birmingham.[8]

A further recognized part of the content of science could be seen to consist of ideas, principles, and conceptual schemes that were intended to make logically defensible sense of observed phenomena and provide experimentally verifiable predictions about them.

The skills and attitudes associated with scientific work were analysed by Karl Pearson in a classic work, The Grammar of Science, in 1892. He argued with much force that science, properly conceived, was competent to tackle all fields of knowledge and eventually to provide a complete interpretation of the universe. Science, in essence, was properly conducted investigation, and the study of science meant, primarily, the study of scientific method. The essentials of method were systematic observation and analysis, a disciplined formulation of a hypothesis, and a testing of the hypothesis logically and empirically.

A vigorous campaign was waged in the pre-World War I period to make scientific method the central part in the teaching of science in schools. The most notable advocate was H. E. Armstrong, a professor in a London college, who in 1897 used the term "heuristic" to describe the method of discovery that, he argued, should characterise the teaching of science. It was, he wrote, "of importance that we be taught the rules of the game of discovery and learn to play it skillfully."[9]

Armstrong had studied in Germany and had come to admire the experimental technique for which Liebig, Bunsen, and Wundt became noted. "When I passed," he wrote, "from the mainly didactic surroundings of an English laboratory into the heuristic atmosphere of a German university...I seemed to escape into an Elysium."[10] The Germans, however, though they

made much of research in their universities, had not introduced it into their schools. Armstrong wished to make the scientific method of discovery the central feature of science teaching in elementary and secondary schools and, if possible, of all subjects in the school curriculum. Like Pearson he saw scientific method as a fundamental and revolutionary contribution to human culture, one which would change the nature of intellectual, social, and political behaviour in the twentieth century. Educators such as Armstrong were also very conscious of the great increase in the volume of material available in science. To include in existing curricula the great quantity of new work that the growth of science and technology was producing would result in impossibly overcrowded school programs. One sensible way of meeting this difficulty was to concentrate students' efforts on the mastery of scientific method and on the study of selected material that would introduce them to the principles and generalizations necessary for the understanding of modern science.

In his view the justification of teaching science was first, utilitarian, in that it helped in the understanding of daily life and was the basis of technological advance, and second, intellectual, in that "it tends to develop a side of the human intellect" mostly left uncultivated, "the faculty of observing and reasoning from observation and experiment."[11] Content was not to be neglected. It should as far as possible be the science of daily life and it should be integrated around problems to which various sciences could make a contribution. But content was less important than method.

Without interesting content, however, even heuristic method tended to become dull and mechanical. It centred round laboratory work to which it gave a great boost in secondary schools, and, on its observational side, there was an emphasis on measurement which sometimes ran to a series of over-precise and tedious exercises. After a period of considerable popularity in the first two decades of the twentieth century, it was severely criticised in England by a governmental committee chaired by a leading physicist, J.J. Thomson, and its influence waned.

The norm for the teaching of science for the next two decades was a broad general course of teacher-centred lessons with appropriate demonstrations and a related course of experimental laboratory and field work.

Armstrong was not a lonely figure in the pro-science campaign. His work and ideas were matched by others in each of the western countries. His American contemporary, for example, E.H. Hall at Harvard, campaigned successfully for the extension of laboratory work and a greater emphasis on precise observation and measurement, an approach which became popular in American secondary schools in the opening years of the century. Nor was the movement confined to scientists. Bury, a leading English historian, in his inaugural lecture at Cambridge University in 1903, expounded the view that "History is a science, no less and no more."[12] In France, Durkheim and Levi-Bruhl worked on the conviction that it was possible to apply to

the study of society the concepts and methods of modern science. Pareto in Italy set about the task of identifying the non-scientific elements in human economic and political thought. In America, Taylor was busy introducing a kind of scientific analysis into business organization, and Thorndike had determined both to practice the science of psychology and to work for the development of a science of education. In his Educational Psychology, published in 1903, Thorndike expressed his commitment to scientific method and the importance of quantifying data:

> It is the vice or the misfortune of thinkers about education to have chosen the methods of philosophy or of popular thought instead of those of science. ... The chief duty of serious students of the theory of education today is to form the habit of inductive study and learn the logic of statistics.[13]

The most comprehensive effort in the early twentieth century to make scientific method into a general intellectual tool to be used as a normal constituent of human culture was to be found in the work of John Dewey. In How We Think (1910) and Democracy and Education (1916), Dewey celebrated the proposed marriage of science and culture. He took the view, not without some justification, that we were living in an indeterminate and problematic world and that human intelligence was the means of understanding it and exercising some measure of control over its further development. Man made his way through it by moving from problem to problem, seeking to bring it under tentative and workable control. In this process, training in problem-solving and the techniques of critical thinking was of central importance. Dewey summed up the essentials of what he called scientific or reflective thinking:

> They are, first, that the pupil has a genuine situation of experience...; secondly, that a genuine problem develop within this situation as a stimulus to thought; third, that he possess the information and make the observations necessary to deal with it; fourth, that suggested solutions occur to him which he shall be responsible for developing in an orderly way; fifth, that he have opportunity and occasion to test his ideas by application, to make their meaning clear and to discover for himself their validity."[14]

This method of thinking Dewey regarded as applicable to every kind of subject-matter, and in his own writing he applied it to social, political, and aesthetic problems. Knowledge of the methods alone however, was not enough. There must be an inclination to use them; hence the need to build up attitudes favourable to the adoption and use of scientific thinking in all appropriate situations -- open-mindedness, a commitment to the problem-solving process, and intellectual integrity.

Later, in the 1930's, Dewey held consistently to his view, and through the wholehearted adoption of scientific procedures, hoped gradually to mould a new culture which would accept process and change as a central

feature of existence, which, forward-looking, would harness scientific and technological forces for the future general good, and which, resistant to prejudice and propaganda, would look to the improvement of human relations by intelligent, democratic, and co-operative means. The heart of the social problems of the time was that intelligence had been applied scientifically and with great effect to the physical world, but "has hardly been used to modify men's fundamental acts and attitudes in social matters."[15] To improve human relations by making scientific procedures characteristic of human thinking and activity was the vital step towards building a first-rate culture out of our present interest in technological and commercial progress. The transformation would not come by looking for some higher culture independent of material and vocational interests but only by accepting our technological civilization, by using the scientific intelligence characteristic of it, and by turning, thereby, "a machine age into a significantly new habit of mind and sentiment."[16] That, for Dewey, was the great educational challenge of the twentieth century, the new age of science and technology.

Ideas similar to those of Dewey were widely diffused in European educational circles by educators such as Claparede, Decroly, and, in particular, Kerschensteiner, a science teacher who became a noted director of education in Munich from 1894 to 1919. Kerschensteiner established a form of continuation education which combined vocational and civic-social education, and, in the public schools, he fostered the study of science through laboratory and productive work. He was reported to take the view that in secondary school, the solution of a problem in chemistry or physics would require an expenditure of thought equivalent to that put into the translation of a passage of Pindar or Horace.[17] Intellectual education, he held, should emphasise the method of thinking and should combine thinking with action. The technological society of the twentieth century, he believed, needed better scientific knowledge for all, better technical education, and better social education in civic responsibilities. He saw a new democratic force coming into being nurtured on co-operation, productive work, and scientific intelligence, and he hoped that his practical contribution to Munich's educational system would be a foretaste of the cultural revolution.

In short, before the end of World War I, the impact of science and technology on education had been examined in some detail by a variety of persons in various countries. Influential educators had analysed ways in which science might be more effectively taught and might take a larger place in the school curriculum. They had recognized, too, that with the rapid growth of science and technology a new and significant factor had begun to transform the cultural scene, and, accordingly, they had put forward serious proposals about the ways in which an associated transformation might be facilitated in education.

For the next twenty years, in the inter-war period, the struggle deepened, as the champions of an embryonic scientific culture searched for an agreed and identifiable form, and slowly infiltrated the established

literary culture.

**Struggle**

In the secondary school teaching of science the most prominent idea to emerge in the 1920's and 1930's was that of general science. If science was to be a vehicle of general education and not primarily a preparation for specialists, there was a good case for producing a school subject which would supersede normal disciplinary boundaries, would be related to everyday life and technological development, and would provide a grasp of fundamental concepts, methods and attitudes of science. It would not be easy to provide such a subject from the various disciplines into which science was increasingly fragmented, but, if it was not possible to do it satisfactorily, was there any sense in talking about "science" as a whole, as a field of knowledge and a way of thinking?

Certainly, in the rethinking of the immediate post-war period, general science caught the attention of curriculum planners. "Today," Russell and Judd wrote in reviewing American high-school education in 1940, "a widely adopted practice is the introduction of a course called 'general science' in which important concepts from each of the fields of science are presented without developing in detail the content of any one of the fields."[18] It was usually taught in the early years of the secondary school program, particularly in the growing number of Junior High Schools, and was followed by biology which was an integration of botany and zoology formerly taught as separate subjects. General science had been available in some high schools since the beginning of the century, and had steadily grown in popularity. In the 1920's and 1930's general science catered for about 18% of high school pupils consistently throughout the period, biology rose from about 8% to 15%, chemistry remained about 7%, and physics about 6%.

Not many students took a complete sequence in science throughout their high school years. In fact the numbers of students enrolled in science courses had dropped noticeably between 1910 and 1915, a fact which produced much criticism of existing syllabuses. The principal effect appears to have been that efforts were then put into making them more practical and more relevant to everyday life. Their popularity increased as their appropriateness to a general education became more apparent. In 1920, the NEA Commission on the Reorganization of Secondary Education, which in 1918 had issued its influential statement of the Cardinal Principles of Secondary Education, produced a report on science. It recommended that science teachers relate their work to home, school, and community life, but on the whole took a rather conservative view and did little to encourage teachers or students into the new areas that were opening up or into the methods of discovery. In the 1930's it was largely left to small groups of progressive teachers to take up the cultural and social challenge of the times.

The depression years of the 1930's provoked much fundamental

rethinking in education. In particular, the relationship of the school to society was substantially canvassed, and some of the finest educational thinking of the century came out of this disturbed period.

The NSSE Yearbook for 1932, A Program for Teaching Science, was an important contribution to science education. It offered a plan for a sequence in science from the beginning of the elementary school to the college, it incorporated the most recent work of educational psychologists on teaching processes, and it gave influential support to an integrated program of science teaching emphasizing the major generalizations of science. The authors pointed out also that, as "our civilization is a highly artificial thing, in the sense that it is the product of man's ingenuity,"[19] the main contemporary sources of that ingenuity, viz. scientific ideas, methods, and applications, should be linked, in our children's education, closely and responsibly with social problems and developments. This approach would make science a central element in a liberal education.

Among the best examples of efforts to relate content to social needs, conditions, and aspirations were the courses and ideas produced by various schools across the USA which took part in the Progressive Education Association's Eight Year Study (1932-41). One of the most interesting tasks attempted by several schools was that of developing a core curriculum of which the content would be based on criteria such as social demands and responsibilities, adolescent needs, or problems of living. In such programs, items from science were built into a pattern shared with aspects of language, art, mathematics, and social science in two ways. Scientific method became part of the intellectual discipline taught throughout the core, and content from the various sciences was related to the social and economic problems raised within the core studies and to contemporary technological developments.

Rugg, a leading progressive educator, originally trained as an engineer, had already published revolutionary new social science textbooks based on years of careful experimentation and intelligent analysis. In The Great Technology (1933) he subsequently sketched the main ingredients of contemporary technological society, and, in Culture and Education in America (1931), argued the case for social reconstruction through an educational reconstruction that would be achieved by developing schools where the core of the work involved the integration of three essential activities: intelligent problem solving, creative production, and appreciation.[20] Scientific experimental inquiry was an analytical tool which needed the support of the methods of creative art if a new and more adequate culture was to be forged. The general education in some of the core programs of the progressive schools revealed a consciousness of the need for some such synthesis.

Rugg's writing was part of a contemporary upsurge in speeches and literature on the social responsibilities of technology which produced in 1932 a much debated scheme put forward by Howard Scott for the

establishment of a technocracy, and widely read volumes such as Stuart Chase's Men and Machines (1929), and Lewis Mumford's Technics and Civilization (1934). It was vividly accented in America by three great fairs, the Century of Progress at Chicago in 1933, and, both in 1939, San Francisco's Golden Gate Exposition, and New York's World of Tomorrow.

It was an era which continued the accelerating advance of science and technology. The neutron was discovered in 1932 and nuclear fission in 1938, chromosomes and genes entered scientific literature, and antibiotics were first developed. The period was marked by "the first large-scale entry of industrial techniques and organization into physical science."[21] Individual scientists began to lead substantial teams, command considerable wealth, use expensive machinery, and work in or relate closely to large government or industrial research laboratories. Cyclotrons, nuclear reactors, cathode-ray oscillographs, and electron microscopes were developed in the 1930's, and became valuable though expensive research tools. In technology, mass production was widely encouraged in the automobile industry and subsequently in the textile, food, electrical, and aviation industries; and polymerization, discovered by the chemical scientist, brought new artificial fibres and plastics on to the market.

The most substantial effort, however, of that time, to build a culture that would be intellectually in harmony with science and technological production, and would place the highest value on developing a scientific perspective in all aspects of life, was not undertaken by one of the the leading technological countries but by the USSR. In building the new society after 1917, technical literacy was as important as verbal literacy. The great design of the new soviet education had been to produce a curriculum that would reflect the Marxist conviction of the prime importance of the productive forces in a society, a curriculum that would put productive work at its centre and provide opportunity for pupils to study and experience various kinds of work and the social consequences of being brought up in a proletarian culture. Practice was never able to match theory. The school was to be a polytechnical one in which students would learn to understand the essence of the productive process and its basis in science, and would be provided with workshops in which they would gain experience in productive work. But in the 1920's equipment was scarce, many teachers were ill-trained, and few really understood what the new approach required of them.

With the advent of the first Five Year Plan in 1928 the curriculum was re-organized; productive work was eventually discontinued in schools, and an emphasis placed on science teaching in which pupils were familiarized with industrial processes and the dependence of the nation's growth on the scientific planning of its development and on the contribution scientists could make to its economic, industrial, and agricultural progress. The Komsomols, the key organization in the youth movement, were told by Stalin:

> "To construct, you must know something, you must master science. ... Before us stands a fortress. Its name is science with its

> many branches. We must take this fortress at any cost. ...A mass campaign by revolutionary youth for the conquest of science -- that comrades, is what we now need."[22]

One of the principal tasks of the school in the USSR, therefore, was to educate its students to participate fully in a scientific and technological society. This meant an emphasis on three things.

First, students must have a suitable vocational education. For this the key institution was the technicum, an upper secondary school providing middle level training for technicians. In the 1930's, entry normally followed seven years of general education, and the technicum provided a three or four year course usually in one of a wide range of occupations throughout industry, agriculture, commerce, and teaching. Vocational training was supplemented by courses in science and in general and polytechnical education. The technicums according to Volpicelli were "the most important of the Russian schools."[23] They were the backbone of the soviet work force, and they, more than any other institution, provided the solid educational basis on which the USSR entered and flourished in the world of modern science and technology. They were supplemented by a wide range of vocational schools for skilled workmen, institutes and universities for higher level professionals, and an extensive network of factory schools and part-time classes, to such an extent that a German observer in the 1930's remarked that "the entire country seemed to be a vast school."[24]

Secondly, the proposed cultural transformation required a substantial general education with a particular orientation. It was provided through the schools and the youth organizations. It had to underpin and reinforce vocational education by giving substantial attention to science and technological production as an area of importance for all students. There was a conscious effort to meld science and technology together, to look at science and its application to technology, and also, starting with technology, to move back to the scientific implications of technological problems. Formal schooling tended to move from science to technology, popular literature and the youth movement from technology to science. The result was an atmosphere of intense interest in the work of both technicians and scientists and an absorption of their practical and intellectual skills.

Thirdly, consideration was given to social education. The technological society of the twentieth century has been found by many workers in various countries to provide a life of little satisfying purpose. Many countries have moved towards a mass society in which many individuals participating in large organizations have little personal involvement in their work, feel lonely and anonymous, and have little power to influence the direction of their lives. For educators in the USSR, however, as one of their leaders, Makarenko, expressed it, man in the mass technological society was not an "isolated individual, now standing out like a pimple, now crushed to dust in the street, but rather a member of

the socialist collective."[25] One of the principal objects of the schools and youth organizations was to help build a collective society by educating students in co-operative behaviour and by providing opportunity for them to share responsibility for planning significant activities and make responsible collective decisions of importance for the groups to which they might belong. This behaviour was then to be transferred, after they left school, to their job situations in the larger factory or agricultural collectives. The capability of the ordinary man to undertake and accomplish tasks of importance and the power of the collective to provide satisfying comradeship, a pool of talent, and great strength of achievement, were brought home to students by example and experience.

In these ways students were motivated to build a new scientific and technological society. Its culture had a distinctive cognitive style, the techno-scientific mode that Veblen had called problem-solving inventiveness, it subscribed to a collective approach to human relations, it was decidedly utilitarian in its treatment of the environment, it favoured in artistic taste a line of social realism that was inspirational and readily understandable by the mass of the people, and it gave little credit to the past, preferring to look forward to the process of creating a new Marxist civilization in which standards and values would rest not on tradition but on the emerging will of the common man.

It was not easy to educate successfully for the proposed, full-scale scientific culture in the USSR, and, at the end of the 1930's, World War II was a drastic set-back to every educational activity. Meanwhile in other European countries such as England and France science education and scientific culture struggled to move slowly forward. Classical education revived in secondary education in France in the 1920's, and, though its flush did not last, it was overtaken in the 1930's not by science but by French. The situation was similar in England where English established itself as the main vehicle of the literary culture. Nevertheless, within that interwar period general science, as in the USA, emerged as a respectable part of a liberal education and influential committees agreed that science of some kind "should be included in the general course of education of all up to the age of about 16."[26] There was considerable criticism of a sterility that had crept into the teaching of the subject, and, in England, the Spens committee in 1939 reported that "the teaching of science has lost touch with life itself and, for this reason, has often failed either to give the knowledge required or to stimulate the pupil's interest." In many schools there was little beyond physical science taught and that with an emphasis on measurement and some standardized laboratory work. The committee argued for the teaching of a wider range of scientific fields with an introduction to scientific method, and suggested, that, while there should be an emphasis on utility, there should also be, as A.N. Whitehead had for years been advising English and American audiences, "an appeal to wonder and interest."[27]

The educational psychologists of the period in Europe and America had substantially discredited faculty psychology and the associated theory of

transfer of training which had been used to justify much of the soul-destroying exercise in precise measurement and laboratory routine. They had also been much interested in studying child development. From research in this field they gradually built up information on the sequential developments of intellectual and emotional behaviour, and the importance of motivation, interest, and activity in learning. Gradually, these finding were incorporated into teaching methods and curricula, and by the end of the 1930's a more psychologically sophisticated practice was beginning to emerge in a number of science classrooms.

**Acceleration**

Undoubtedly World War II accelerated technological development and led to an increased interest in science. Bernal has pointed out three stages of science in the twentieth century. The early period was an era of private science, followed in the twenties and thirties by the stage of industrial science. The third stage, seen first in the USSR, was that of governmental science which became universally the rule during World War II and remained so in the post-war period.[28] Each stage was increasingly productive and led to substantial technological developments. In the post-World War II period while government support for science and technology accelerated, notably for military and space programs, industrial support for science also continued to grow, often in conjunction with government agencies and government assistance. The increase in scale was accompanied by a widening of the scope of scientific work and a multiplication in the number of scientific workers.

The twenty year period from 1940 to 1960 capitalized on the discovery of atomic fission by producing an atomic bomb in 1945 and building up a sizable atomic industry thereafter. It saw the beginning of the space age with the launching of Sputnik, the first artificial earth satellite, in 1957. Radar and radio astronomy were developed, television and transistors came on the market, computers started to come into fashion, the plastics industry proliferated, and the field of antibiotics was widely opened up. To cope with this acceleration a continual increase in trained manpower was needed and, in addition, a high level of public support to provide adequate resources.

In the mid-fifties a reform in the teaching of science began in the USA and spread rapidly to most other western counties. The first of the projects was in mathematics and was followed by one in physics under the direction of the Physical Science Study Committee (PSSC) in 1956. Sputnik in the following year stimulated further reexamination of the teaching of science in high schools which, the critics suggested, had fallen behind the academic quality of work in the USSR. Many projects followed in other subjects and in various counties, and they were conceived on the substantial scale and organizational pattern of the PSSC. It brought together academics in physics and education, educational administrators, and teachers, in joint committees supported by state and private funds. It

was an attempt to produce statements of aims, principles and content, and text materials and kits embodying the up-to-date scientific knowledge of the professional scientists and the educational wisdom of the professional educators in a program for teaching physics to senior secondary school pupils. It was soon followed by other substantial projects in the USA, such as the Chemical Bond Approach, School Mathematics Study Group, Chemical Education Materials Study, and the Biological Sciences Curriculum Study.

In Europe curriculum reform followed the American start, and in 1964 a substantial review of the curriculum was undertaken in the USSR. The first projects in Europe were also in mathematics and science. France established a commission to reform those subjects, in West Germany numerous projects were undertaken, and in England the Nuffield Foundation funded a Science Teaching Project for the 11-16 age group in 1962 followed by more projects for other groups, and the Schools Council cooperated with Nuffield on Science 5-13 in 1967 and Project Technology in the same year.

Throughout the whole of the movement there were five common features. First, there was a search for relevance. Project Technology, for example, illustrated an effort to direct the students' attention to material that was related to contemporary life and to the contemporary state of knowledge in the field being studied. There was a strenuous effort to discard outmoded material and to bring science teaching up to date. The curriculum was designed, accordingly, to teach students to understand and be precise in using the terms of modern science and to encourage them to think scientifically.

In a rapidly changing world, relevant subject-matter also meant the kind of subject-matter which would best enable students to cope with and grow with the changes that would confront them. Relevance of that kind came from an understanding of the fundamental principles and the structural framework of the developing subject. The PSSC program was based on that view. Specifically, for science, this began a new departure in thinking about the content of the science curriculum. Schwab and Bruner had recently been arguing vigorously that each subject was a specific discipline which was to be found in the particular structure of that subject.[29] The structure of the subject, therefore, was the essential matter that schools should teach. Currently there was much unresolved debate about the nature of discipline and structure, and it had the effect of forcing a much closer examination of the fundamental ideas, methods, and interconnections which might give coherence, meaning, and a valid academic introduction to each subject.

The large projects of the PSSC type emphasized the acquisition of the structure of subject matter, building their programs around major principles, conceptual schemes, and the process of science, and encouraging in-service education courses on the nature of structure and ways of dealing with it. Like the educators at the turn of the century the curriculum developers of the 1950's and 1960's were also very conscious of the

knowledge explosion of their times. It had become obvious that school curricula were not keeping abreast of current advances in scientific knowledge and that it was pointless to try continually to cram more into school programs. To concentrate on discipline and structure was one useful way of trying to cope with a knowledge explosion which obviously was destined to continue indefinitely. The approach was duly supported by teachers' bodies such as the American National Science Teachers Association whose report in 1964[30] advised its readers that an understanding of conceptual schemes and complex inquiry skills was the central concern in the teaching of science.

The second feature of the projects, related to the first, was an emphasis on inquiry and discovery after the fashion of Armstrong's heurism. On almost every project, whether in science or not, students were to learn the techniques of inquiring and experimenting, and by practising them, build up an attitude of critical questioning. In that matter, the curriculum movement was still thoroughly Deweyan, aspiring to cultivate the exploring mind, the problem-solving person receptive to change, the twentieth century citizen at home in indeterminate situations. These skills and attitudes were characteristic of many of the projects not only in science but also in social science and in language work. In these projects education moved a step closer towards the cultural change, advocated by earlier educators such as Dewey and Kerschensteiner, that would bring scientific thinking into the central place in all intellectual activities.

Thirdly, the movement put an emphasis on the self-activity of the students. They were encouraged, for example, to think up their own apparatus for scientific experiments and to look to common experience for examples of the ideas and principles they were learning. This too was an approach shared by projects in the humanities and social sciences. The new English, wrote a secondary school teacher in England, had "a life not a belles-lettres approach."[31]

Fourthly, the courses, particularly in science were more carefully planned and sequenced. In the USSR the sequence of science teaching throughout its 10 year all-age schools was tightened. It ran smoothly from the introductory biological studies of the elementary grades to the more advanced secondary work in biology, physics, chemistry, and astronomy, and increased in weight up to the final grade level where, with mathematics, it was built up to about 50% of the standard curriculum. In the USA, in the Third NSSE Yearbook of 1904, there had been a strong recommendation to establish a sequential course in science from the kindergarten to university. The advice was repeated in the 31st Yearbook in 1932.[32] In the 46th Yearbook the importance of such a sequence was reemphasized, but, as secondary school science was "in a state of flux," the authors were unable to offer any firm guidance.[33] Again, the 59th Yearbook in 1960 repeated the wisdom of 1904, and pointed out that articulation of a 12 year science program was a continuing problem not yet satisfactorily dealt with by the schools.[34]

Fifthly, the movement made extensive use of current innovations in teaching techniques, especially in the audio-visual area. The use of films, videotapes, gramophone records, tapes, transparencies, radio and TV programs, provided a practical example of technological achievement in aid of the student and classroom teacher. More importantly there was a renewed attention to the processes of learning and teaching.

It was a movement which had a continuing life. Individual projects might terminate after 2, 5, 10 years or whatever number of years might be their specified lifespan, and others would take their place as new ideas or new needs were discovered. Thus from 1956 to the present day projects, offspring of the original mathematics and PSSC programs, have continued to accumulate. For example, a listing of science and mathematics projects that had been initiated between 1956 and 1976 had about 500 entries for the USA, and another 300 for other parts of the world.[35]

In the area of science education much useful research was generated in many countries. A significant area of research was on the design, dissemination, and teachers' use of new curricula. Studies of intellectual processes were also fashionable; e.g. the relationship of cognitive structure to learning and teaching styles, the way in which children build and use frameworks of understanding, and, most popular of all, Piagetian studies on stages of cognitive development. This work has continued to the present time in an increasing amount and has produced useful implications for teaching processes and learning sequences.[36] One of the most interesting pieces of research was a study of achievement in science by students of secondary schools in 19 countries conducted by a distinguished international group, the International Association for the Evaluation of Educational Achievement (IEA). It showed among other things that a student's successful performance in science was related positively both to his being male and to his being educated in a technologically advanced country.

**Disillusion**

The early years of the curriculum development project era were a period of great enthusiasm, more intense than and somewhat similar to the early years of the century. "Never before," wrote a yearbook contributor in the USA in 1960, "has the concern about the improvement of secondary school science been as widespread as it is today."[37] Student numbers in most countries increased rapidly, and an emphasis in teacher education was placed on the recruitment and training of science and mathematics teachers. A greater variety of courses in science was introduced. Junior and senior levels in secondary schools had carefully differentiated science courses, and, in many schools, courses in the study of technology were introduced. Laboratory facilities were multiplied and teaching materials were greatly increased.

In some countries where a reconstruction of secondary education was taking place special attention was given to the requirements of science and technology. Thus, in France, the 1966 reform of the baccalaureat specified five main options (literary, literary and scientific, mathematical, experimental sciences, and technological), and the secondary school structure recognized the development of technical lycees alongside the general lycees. It was an effort in the words of a French educator to prepare ourselves to "be men of our times, seeking not the survival of our civilization **in spite of** technology, but rather to consider, ... as Louis Armand asserts, "technology as a means of civilization."[38]

Within a few years the scene had changed. Enrollments in science began to slip back. Even in the USSR, where success in space technology had enthused the youth of both sexes to put greater effort into their school science work and to develop scientific and technological hobbies in their pioneer palaces, a decline became apparent. Participation in scientific activities began to wane, scientific topics in the optional part of the school program were less frequently chosen, and a slightly smaller percentage of entrants to tertiary institutions found their way into science and technology courses. It did not mean that the scientific culture of the USSR was undergoing a substantial change, but it did mean that the 1960's euphoria could no longer be so clearly detected.

In the western countries enrollments in the standard science courses began moving back to pre-Sputnik proportions. Except for brief flurries of enthusiasm, science in schools or science as a topic of conversation has not been of great popularity throughout this century. After a great forward move at the beginning of the century, there was a decline in the 1920's and 1930's, a massive expansion in the 1950's and 1960's, and a downturn by the end of the 1960's. In the mid 1970's the decline in popularity became quite apparent. In many countries the proportion of students in science courses was diminishing, and in some of the other countries the actual numbers were decreasing. "What is it," a sociologist asked in 1974, "about the way we conceive of science, and the way school science is experienced, that restricts a major human activity to a minor pursuit?"[39] It has been quite common, in Western countries, to find small adult circles meeting to discuss a book or play or some aspect of literature, but where, outside of professional institutions, do you find a circle interested in discussing aspects of science?

Science teaching has been regularly criticised since the beginning of the century for its undue dullness and austerity. "The dreary performance of meaningless qualitative analyses in chemistry is a case in point," from English critics in 1942; "...massive doses of facts without conceptual order. ... The facts are divorced from anything that might be called the process of inquiry," from an American writer in 1962; and "...students ... anticipate a demanding course of memory, not a course that encourages creativity and critical thinking" from a teacher in 1971.[40] From the point of view of the wider public and those brought up on the literary tradition in western countries, modern science has an incomprehensible

vocabulary and a body of puzzling ideas. Snow in 1959, and again in 1963, drew attention to the progressive development of the two opposing cultures. "I believe," he wrote, "the intellectual life of the whole of western society is increasingly being split into two polar groups ... Literary intellectuals at one pole -- at the other scientists, and as the most representative, the physical scientists. Between the two, a gulf of mutual incomprehension..."[41] He regarded the rift as serious, and took the view that "there is only one way out of all this: it is, of course, by rethinking our education."[42]

In the 1960's and 1970's there was a further source of vigorous criticism. It was the time of the Vietnam war. Scientific work was seen, particularly by students, to be heavily financed by and closely connected to military activities. Its research produced military and industrial technology which both supported an actual war and built up nuclear, chemical, and conventional weapons throughout human society to a level and to a destructive power never previously even approached. The continual expansion of industry caused misgivings about the rate of consumption of the world's non-renewable resources, and was also responsible for pollution by smog and other chemical and radio-active wastes. The destruction of the environment that was associated with the advance of science and technology caused widespread protest. These kinds of substantial public objections obviously tended to undermine any claims made by science teachers that science should be regarded as one of the humanities. Many scientists, however, were among the more knowledgeable of the protesters, and their concern helped to direct more attention to the development of science courses which made a study of the social and environmental effects of science and technology.

In primary and junior high schools some moves were made to design courses which combined science with social studies. At various secondary school levels in most countries topics on the social effects of science, of the application of science through technology, and on the care and maintenance of the environment were introduced. Additional subjects, too, such as environmental studies appeared, and social issues involving scientific work became part of literature, history, and social science courses. Nevertheless, the report of a conference in 1980 stated that the participants had met because of

> a crisis in education. ... Typical high school courses were considered to be woefully inadequate in addressing those many current problems which require scientific knowledge for their understanding -- e.g., energy, pollution, population resources, genetic engineering -- and in providing students with the background knowledge and problem-solving skills they will need in their lives.[43]

Summary

Throughout the course of the century various educators have been involved in rethinking the approach to be taken in science teaching and the design through which the approach might be expressed in the curriculum. For these educators there have been two fundamental problems to be tackled: (i) how to develop and present science so that it may become the cultural basis of present day society; (ii) how to plan and implement science as a secondary school study for both non-scientists and prospective scientists. The first task would require us to encourage a general disposition in society to think and to act somewhat like scientists, to understand and to enjoy science, and to wish to further its development. The second would involve developing secondary school courses in science, and in other sections of the curriculum, which would interest the ordinary student in science, benefit him intellectually, and provide him, according to his capacity, with an up-to-date knowledge of the main ideas and directions in which science has been moving; and, at the same time, provision must be made for effective scientific education for the students who may make science their profession. Both questions are closely related. The effort to build a scientific culture rests, as Snow pointed out, to a substantial degree on the establishment of an acceptable program of general science teaching in secondary schools; and success in establishing science programs in strength in secondary education is dependent in large part on public support from a society which has been brought up to understand and care about the development of science.

For some, both the more missionary and the more mercenary of scientists and teachers, the first question was the significant one. Dewey, a seminal American philosopher of education, proclaimed that scientific method should become the basic intellectual element in democratic culture; Makarenko, a paragon of Soviet educators, worked for a scientifically planned collective society; Bondi, a notable scientist and administrator, argued for more effective marketing of science to the public. All, with different emphases, looked forward to the time when science was to become the central and sustaining part of the world's culture. But the movement, to the present point in the twentieth century, has met with indifferent success.

For most school teachers of science it was the second question that was of principal interest to them -- how to develop appropriate secondary school science courses. Discussion and experimentation on this question had, over the years, been extensive and somewhat repetitive. In western countries it has followed approximately the sequence outlined briefly and schematically in Table 1.[44]

In the table, four basic curriculum approaches have been selected as representative of the main lines along which curricula have been organized from time to time. All four approaches were enunciated by educators at the beginning of the century with varying degrees of conviction and acceptance. They were also present in each subsequent period but in a somewhat

different order of significance. It is interesting to note, however, the similarity in emphasis between 1900 and 1960, and between 1930 and 1980. In the case of the first pair, 1900 and 1960, there was a similarity of background in a perceived threat to national prestige and technological leadership by an external power, recent substantial developments in science and technology, and also a growing dissatisfaction among professionals with the existing level of the teaching of science and its general cultural ranking. In the case of the second comparison, 1930 and 1980, important common factors were a widespread economic depression sharpening up social awareness, and an interest in the findings of psychological research on cognitive development and learning in science.

For the greater part of the century, four emphases -- systematic order, utility, scientific method, and social application -- were most common and persistent, and were to be found within each period, sometimes one leading and sometimes another. There were three periods in which a particular emphasis appears to have been dominant. In the pre-World War I period (c. 1915) scientific method made the running, in the great depression (c. 1930) the social application and responsibility of science was the most cogently argued emphasis, and in the post-Sputnik period (c. 1960) disciplinary structure and method permeated all the curricula in science. The traditional approach, that of an arrangement and presentation of scientific facts and generalizations in systematic and logical order, was inherited from the nineteenth century, was affected by the other three emphases in the extensive rethinking that took place early in the twentieth century, and was remodified from time to time during the following years, but never lost its grip on the curriculum. It was a continuing line of conservative influence yielding to and absorbing other influences but remaining recognizably the same approach.

Inertia, in so far as it was maintained by factors within the curriculum, appears to have come from the existence of such a well-established traditional approach and also from the fact that there was a group of well-balanced approaches to the subject. This comprehensiveness precluded the emergence of any fresh, great novelty. It proved quite possible, and indeed usual, when one approach was accented, to keep going at the same time with the others. Innovation appears to have been associated mainly with external influences, in particular with social and cultural conditions interpreted by concerned individuals, and with notable advances in science and technology which managed to stimulate educators by their significance or popular appeal.

TABLE 1

Stages of Science Teaching in Secondary Schools in Western Countries

| Approx. Date | Sequence of Curricular Changes | Order of Priority of Curricular Emphases | Acronym |
|---|---|---|---|
| 1900 | Traditional Approach (presentation of organized facts) | Systematic Order | O |
| | Social and Economic Demand | Utility | U |
| | Questioning of approach, Reformulation of a comprehensive set of general aims | Scientific Method | M |
| | | Social Application | S |
| | Innovation (Problem Solving) | | |
| 1915 | Routinization of Innovation | Scientific Method | M |
| | Modification and continuation of traditional approach | Systematic Order | O |
| | | Utility | U |
| | Suggestions for re-examination | Social Application | S |
| 1930 | Social and economic demand, Psychological analysis | Social Application | S |
| | More extensive re-examination | Scientific Method | M |
| | | Systematic Order | O |
| | Innovation (social responsiveness in science curriculum) | Utility | U |
| 1945 | Elaboration of a new social direction | Social Application | S |
| | | Utility | U |
| | Continuation of re-modified tradition | Scientific Method | M |
| | | Systematic Order | O |
| 1960 | Reaction and re-examination | Systematic Order | O |
| | Innovation (structural approach and revival of problem-solving) | Scientific Method | M |
| | | Utility | U |
| | | Social Application | S |
| 1970 | Continuation of further re-modified tradition | Systematic Order | O |
| | | Scientific Method | M |
| | Dissatisfaction and re-examination of curricula | Social Application | S |
| | | Utility | U |
| 1980 | Revival of social responsibility approach and psychological studies of cognition | Social Application | S |
| | | Scientific Method | M |
| | Continuation of much re-modified tradition | Systematic Order | O |
| | | Utility | U |

**Rethinking**

Towards the solution of the two general problems of science education -- how to develop the cultural potential of science and how to produce science curricula seen by students to be an essential part of their education -- the re-thinking of the 1970's and 1980's had become involved with five important questions, each of which emerged earlier in some fashion during the course of the century. The first three are questions concerned with the design of existing science curricula, the last two also affect science curricula but have a broader significance for education and culture. The five questions relate to the sequence of study, intellectual challenge, the relation of technology to science, the role of science as a humanity, and the place of science in general culture.

First, is it possible to develop a sequence of science studies from kindergarten through to primary and secondary schools (K-12)? Such a sequence has been frequently mentioned and recommended since the beginning of the century. It was developed effectively in the all-age schools of the USSR, and revised from time to time, notably in the 1960's. The Nuffield and Schools Council programs in England in the 1960's and 1970's were examples of efforts by practising teachers to develop workable sequences. If such courses were more widely adopted, in England and elsewhere beyond the "tiny minority of Schools" reported in 1979 to be using them,[45] there would be a much greater possibility of developing the scientific literacy in the population that their designers seek. An appropriate K-12 sequence taken throughout by all students would probably improve the level of work achieved on the completion of the secondary course. It might accustom students to use patterns of scientific thinking, and thereby begin to build some of the main intellectual and attitudinal elements of science into the society's culture.

Second, can science in secondary schools be made more intellectually challenging? Tyler, in the 59th NSSE Yearbook, neatly outlined the general intellectual objective of science teaching when he suggested that learning science was essential for every boy and girl "because science is ever at work constructing a comprehensible and orderly system of explanations for natural phenomena and building a basis for intelligent control and utilization of the natural world," and that the student "must understand science as a continuing process of inquiry."[46] The heurism that Armstrong introduced made science more intellectually challenging; and Dewey elevated inquiry learning into a systematic approach to every aspect of living in a problematic world. But what in teachers' hands became almost a stereotyped Deweyan method of inquiry was not enough. It did not cover the wider range of mental processes that various kinds of inquiry use; for example, in the case of historical and legal studies the processes of judging the validity of an authority, of classifying activities and phenomena, of balancing probabilities, and of constructing schema or models that are testable not by action but only intellectually.

In the discussion of the 1960's and subsequently it was made clear

that science was not merely a bundle of established facts growing cumulatively by further inquiries, but was also a body of interrelated concepts and creatively developed conceptual schemes subject from time to time to revolution. Kuhn pointed out that science was not all of one piece, and was subject to "essential tension" and crises as established explanations were challenged and supplanted by more acceptable ones.[47] He and other scientists were highly critical of existing textbooks both because teaching was unduly dependent on them and in consequence became "a narrow and rigid education," and because by giving the impression of a stable authoritative discipline they gave a false impression of the nature of science.[48]

It is not easy to reconcile the respective demands of content and process in science teaching. A more intellectually challenging course in science would have to do so. It would have to ensure that students build up experience of a range of inquiry processes, gain a knowledge of significant concepts, have an opportunity of examining the way conceptual patterns are formed, and acquire a body of consolidated scientific knowledge that they acknowledge not as dogma but as conclusions that, in Dewey's terms, have reached a level of "warranted assertability."

Third, can science teaching establish an organic relationship between science and technology? A persistent aim of science teaching has been that of utility. To demonstrate utility it is customary to refer to the applications of science. Throughout the course of the century the use of such technological illustrations has been, for the most part, a token gesture. Technology for most of its long history was unrelated to science. In the nineteenth century the importance of building a relationship became apparent. Lyon Playfair wrote in 1851, "As surely as darkness follows the setting of the sun, so surely will England recede as a manufacturing nation, unless her industrial population become more conversant with science than they are now."[49] During the twentieth century, technology and science have everywhere become so closely associated that the relationship has been described as symbiotic.

The contribution of science to technology is made reasonably clear in school programs. The contribution of technology to science is less canvassed but is of considerable importance. It contributes the hardware such as electron microscopes, cyclotrons, and computers, which have widened the scope of scientific work and become essential to many areas of science. Technological problems have been the source of a considerable range of scientific problems, for example in ecological studies, chemistry, and atomic physics. And perhaps most significantly for science teaching in secondary schools, the social applications of science are disclosed through technological developments. Science is expressed in two ways: as an exploration of the natural world by human intelligence through its own methods, ideas, and discoveries, and as an impact on the natural world through technology. Both expressions of science are important for the student of science to grasp. The two have not yet been taught together to much effect.

In the USSR where, of all societies, science has come closest to being an integral part of the culture, productive work has long been a theoretical and practical part of the curriculum. It has not usually emerged, however, as a productive expression of science, and has not always been regarded as a satisfactory part of the curriculum.

To be an adequate study, the technological impact of science would need to involve a consideration of the scientific ideas from which a particular technological product is derived, the methods by which scientific work is converted into technology, and the social and environmental effects of the design, production, maintenance, and further development of the technological product.

Fourth, can curricula be produced through which science will be accepted as a humanity? There is no magic simply in the name "humanity," nor in the subjects of the secondary school curriculum that are assembled under its banner. What is important is that schools should teach programs through which a student may learn how to examine what has been called the "active mind of his own age,"[50] and from his contact with a living and dynamic tradition, gain some illumination in intellect, taste, and imagination.

Is it possible for a study of science to perform this function? Perry, a leading American philosopher, made an interesting analysis in 1938 of the nature of the humanities and the possible inclusion of areas such as science in a liberal education. He argued the view that there were five main ingredients to the humanities: learning which brings a wide awareness of "the laws and natures of the known world and of the procedures of knowledge;" imagination which "enables the mind to entertain mere possibilities of truth;" sympathy which helps us "to penetrate to the centres of other men and share the outlook of their emotional life;" a human dignity which rests on the possession of freedom to exercise enlightened choice; and civility, an attitude of courtesy and forbearing which promotes "a genuine reciprocity of intercourse." Any activity, he concluded "which broadens learning, stimulates imagination, kindles sympathy, inspires a sense of human dignity, and imprints that bearing and form of intercourse proper to a man, may be termed 'a humanity.'"[51] It has intellectual, emotional, social, and attitudinal elements of a distinctive kind.

Perry could see some of these elements in science. It was, in his view, a humane study in so far as its learning provided an understanding of the actual world and the intellectual ways of investigating it, and an opportunity of imaginative speculation. But scientists and teachers of science, he felt, did not do the subject justice; they perpetually dehumanized it. Its strength was seen to be in its technique, and its value in the utility of its technology. Even the social sciences had imitated the natural sciences and forfeited much of their claim to be humane studies. Where technique became method that was consciously

reflected on, it became subject-matter and ceased to be a routine acquired by mere training.

Dewey's view of scientific method and its wide applicability to the exploration of an indeterminate world would have satisfied Perry as a humanistic effort to cultivate the intellect. But as it was generally taught and justified in the secondary schools of the USA and western Europe science did not thoroughly qualify on Perry's criteria. Even if it did, it would, as Dewey admitted, be no quick and easy task for it to be accepted as the basic element in humanistic studies or as the underpinning of a new and living culture. More recent and more sophisticated analyses of scientific procedures, however, have tended to underline the extent to which science shares common processes and attitudes with other intellectual disciplines.[52] On such a view, the prospects of incorporating science into an extended version of the humanistic studies might be more readily accomplished.

For science to achieve acceptance as a basic humanity, the science curriculum would have to be designed to effect four things:

- to teach convincingly the viewpoint that Bondi expressed that science is a social exercise of the human mind, that science "is so utterly human. ... Surely if there was a thoroughly human enterprise, it is science -- because there is nothing else in which people can cooperate, and depend on and make use of each others' work so universally. ..."[53]

- to provide curricula for non-specialists which will give them the kind of challenging intellectual experiences that were mentioned above, the fundamental vocabulary and ideas of modern science, and an encouragement to look for patterns which help them begin to grasp the range of the sciences, and their inter-connections, their present frontiers, and their total contribution to society's culture.

- to provide experiences through science and technology of activity that is imaginative and creative, and to ensure that it is seen not to be exceptional or occasional, but an expected part of scientific activity in the same sense that imaginative and creative experiences may be expected in the study of literature or art.

- to show that in science there is an opportunity to develop a caring attitude towards the quality of one's own work and the scientific and technological product of it. As in the humanities, it is possible to develop a style of work, and to develop an elegance in it and in the construction of the technological outcome. It is possible also for scientists to learn to examine responsibly the social effects of scientific and technological programs and to discuss in an informed, rational,

and sympathetic way the merits of putting them into operation.

Science with these suggestions in mind would go far toward meeting Perry's intellectual, emotional, social, and attitudinal criteria for a humanity. It might also become a popular subject in secondary schools.

Fifth and finally, can science be offered as an integral and accepted part of public culture? Much of the activity involved in making science sequential throughout the school system, more intellectually challenging, more organically related to technology, and more acceptable as a humanity would have the effect of building science more thoroughly into the consciousness of the general population. The strength of science in the USSR is built not on the reputation of a few specialists but upon general popular interest and support. It has become an integral part of Soviet culture. The press, radio, TV, and popular literature are heavily scientific. There is wide interest in scientific education and the activities of scientific institutions are generally understood and thoroughly encouraged.

If science and technology in western countries are similarly to become part of the general culture three problems have to be tackled:

- The proportion of students studying science has to be raised to saturation point, where all students in secondary schools are studying science courses for the full period of their secondary education.

- Communication between scientists and the public must be considerably increased, so that science and scientists become comprehensible to the ordinary citizen. The mass media must begin to pay substantial attention to scientific and technological matters, and to act in a more scientific way. At present, by the effective presentation of bias and by encouragement of advertising which relies on authoritative and repetitive assertion and the blandishment of half-truth, it has become a form of technological development that acts powerfully against all efforts to teach effectively the use of scientific method and the adoption of scientific attitudes.

- Scientists must be accepted not as neutral bystanders in social issues but as a doubly valuable resource -- a means of acquiring desired, necessary, and understandable information, and an aid in determining the worthwhileness of any course of action which involves technological construction and its possible implications.

It would be idle to suggest that any of the above suggestions could be accomplished easily and quickly. It is clear that they have so far been implemented very incompletely. Forty years ago two English science teachers complained that although science might be the great instrument of

social change, western civilization remained resolutely pre-scientific.[54] The 59th NSSE Yearbook in 1960 recorded that "Little has been done in science classrooms" to attain some of the most important objectives of science teaching.[55] And in 1981, a French historian of education began his chapter on science education with the heading "A disastrous balance-sheet: world-wide, science education has not changed," and went on to explain that for most primary and secondary schools in the world the teaching of science for the past 40 years, in both developed and developing countries, has remained descriptive, teacher-centred, and authoritative.[56]

The position, however is not quite as melancholy as it might be made to appear. Although not all commentators would be in agreement on precise details, it has been shown by many writers that the work of scientists has a cognitive style, does show evidence of imagination and discernment and has a contribution to make to social understanding. This is an important achievement. But it is not enough simply to identify these characteristics. They must be shown to be worth having. Writers as diverse as Dewey, Bernal, Julian Huxley, Oppenheimer, and Bronowski have argued the importance of making scientific knowledge, skills, and attitudes more widespread. They suggest the need to match the physical impact of science and technology with a powerful cultural influence. It is not to be a cultural influence of opposition but one developed as a new humanity out of the scientific and technological ideas and practices which pervade the civilization of the twentieth century.

To achieve such a goal these characteristics of scientific work must be effectively communicated and accepted throughout society as characteristics of general desirability. This has not been systematically attempted in western society. In one of the cultural agencies, however, the secondary school, where the teaching of science has slowly made headway, something of the general characteristics of science has penetrated through the curriculum. Social science, for example, much more widely taught in the 1980's than at the beginning of the century, has absorbed the methods and the social concerns of the sciences. The methods of teaching in the sciences themselves may not have moved much, and the curriculum may have been unduly stubborn, but, at least the primacy of the literary classics acknowledged at the beginning of the century has been challenged with some success. In most countries, by 1980, the sciences had become an accepted part of the core of studies of the secondary school beside the literary studies and the social sciences.

The campaign has not yet been completely successful either to remould twentieth century culture or to remake the science curriculum; but at least both tasks have been seriously approached, and, in the past decade, there has been a considerable acceleration in both action and thought.

NOTES

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# THE CONCEPTUAL BIOLOGY OF SCIENCE EDUCATION

George J. Posner

Professor Connell's paper examines the cultural change that has accompanied the growth of science and technology in the 20th Century. Specifically, he considers one manifestation of cultural change -- changes in the goals, content, methods and theoretical perspectives of educational systems, in general, and of science education, in particular. Professor Connell concludes that there have been two general problems for science education: how to make science the cultural basis of modern society; and how to produce science curricula seen by students as an essential part of their education.

I would like to focus on two of the questions that Connell discusses while urging us to rethink these problems: how to produce curricula through which science will be accepted as a humanity; and how to offer science as an integral and accepted part of public culture. Of the five questions Professor Connell raises, these two are clearly the most profound, having "a broader significance for education and culture." To make science a humanity he recommends we change the goals, content, and instructional strategies of science education. To make science a more integral part of culture he suggests we increase the scope of influence of science educators and scientists.

I will argue that Professor Connell's approaches to the current problems of science education are insufficient and do not take fully into account the intellectual context of educational stability and change. My interpretation of the factors that maintain an educational tradition and, therefore, the factors that must be taken into account in any attempt at fundamental educational change centers on the residual philosophical, psychological, and social-political ideas our predecessors have left behind. Rather than attempt to change science education directly, which in turn would produce cultural change, as Professor Connell suggests, my view requires a change in our current stock of ideas about science and education, many of which we have inherited from the Deweys and Thorndikes of the past, and about the role of education in social and political systems. In other words, I want to suggest that influential scientists, sociologists, philosophers, psychologists, and educators have left a legacy of ideas, producing a residue of interrelated beliefs. These beliefs affect the kinds of changes science educators and the public alike will consider reasonable.

This legacy of ideas functions as a kind of "conceptual ecology" into which new ideas must fit. Unfortunately, Professor Connell's ideas of science as a humanity and of science as an integral part of a culture are unlikely to find an available niche within the network of prevailing views about science, scientists, and science education. Without an available niche, the changes Connell considers important will be impossible.

Therefore, only as the conceptual ecology changes can we expect science education to change.

I shall discuss three kinds of legacies that are important features of the current conceptual ecology of science education: the epistemological legacy influences how we view science and the work of scientists (i.e what counts as **science** education); the psychological legacy influences how we view learning and thus the kind of teaching and curriculum we consider effective (i.e. what counts as reasonable science **education**); and the social-political legacy, particularly society's moral and political aspirations, strongly influences the use to which science is put and society's educational aspirations. Each of these legacies can be viewed as a response to a set of questions.

What is science? According to the **epistemological legacy**, science is a systematically organized and stable set of facts and laws derived from observation. Because science is inherently difficult, to try to make it less difficult is to reduce standards, changing science from the "real thing" to some "watered down" version.

How does science change? According to this legacy, science changes as a result of the accumulation of new facts and observations and the refinement of generalizations based on them. New theories tend to be expansions or refinements of old theories rather than replacements of them.

What is the relationship between theory and observation? Observation is central to science according to this tradition. Theories are generalizations of observations and are ways to describe patterns in what we observe. They serve as summaries of our observations. Validation of scientific theory is a matter of replicating these observations in order to ensure their reliability and of collecting sufficient observations to warrant generalizations based on them. Validated theories can be considered correct and alternative theories incorrect.

What is the "scientific method?" According to this view, the scientific method proceeds as follows: recognition of a problem; definition of a problem; development of an hypothesis; testing of the hypothesis; and verification.

What is learning? In the **psychological** tradition we have inherited, learning is the acquisition of new skills or information as evidenced by being able to answer questions and problems correctly. Skills are learned through practice while information is learned through drill and repetition. With regard to the acquisition of information, students are typically blank slates on which the instructor must write. For skill learning it is only necessary to find out whether or not students possess the prerequisite skills.

How does one solve social problems? According to the prevailing **social-political legacy**, particularly in the United States, social problems, like other problems (including educational ones) are solved by scientific investigations and the development of appropriate technology. To be "useful" science must help us solve social problems.

Who should learn science and why? Science education seems to be influenced by the view that differences in income and political power are meritocratically based. Expert knowledge is required for making important policy decisions and, therefore, these decisions should be left to the experts. Only the brightest students are capable of becoming experts and thus of gaining the economic and political advantages given to the well-educated future leaders of society. Therefore, only science education for the future leaders must emphasize real understanding of and doing science. The masses (i.e., the average and below average students) have no need for, and are not capable of, fundamental understanding in science. For them, memorization of scientific facts and practical application of this knowledge to the world in which students must function is most appropriate.

These three legacies produce a conceptual ecology with the following characteristics:

- A stress on examinations and correct answers;
- A view that science is difficult, particularly physics and chemistry, and that science courses sort out the able from the less able;
- An emphasis on observation, measurement, prediction, and hypothesis testing;
- A clear distinction between theory and fact;
- A failure to attend to students' preconceptions and thus a failure to change them;
- Lecture-recitation methods with labs primarily devoted to manipulation, observation, and verification;
- Ability grouping with lower ability groups having less access to science courses and more courses emphasizing facts and practical applications.
- A perception that science is only for those going into science careers and, therefore, that it is not relevant to most people's lives.

I would like to suggest that a different set of epistemological, psychological, and social-political ideas would provide a very different conceptual ecology, a conceptual ecology with available niches for Professor Connell's ideas of science as a humanity and science as an integral part of a culture. This set of ideas would include a philosophy of science based on a conceptual change view of the growth of scientific knowledge, emphasizing the sometimes radical nature of the revision of scientific theory and the theory-dependent nature of scientific observation and method (e.g., Kuhn, Lakatos, Brown, Strike and Posner); a cognitive psychological theory of learning (e.g., Driver) emphasizing the significance and rationality of the alternative frameworks students bring to instruction and the need to utilize cognitive conflict in changing students' beliefs; and a social-political view emphasizing the social construction of reality, the political, economic, and moral aspects of social (including educational) problems, the importance of citizen participation in policy-making and, therefore, the need for accessibility of science to **all** citizens.

In summary, Professor Connell suggests that we produce cultural change by changing science education. I have argued the difficulty in such a venture and Professor Connell's brilliant historical analysis as well as Stake and Easely's case studies, Goodlad's study of schooling and other researchers have supported this claim. I have suggested here that the cultural context of science education must change if science education is to change in a fundamental way. We thus have a classic chicken-and-egg problem. Clearly the way out of this problem is to look for complementary changes in both our practice of science education and, simultaneously, changes in our epistemological, psychological and social-political assumptions regarding science education. Any agenda we might have for science education must be coupled with agendas for general education and teacher education aimed at changing prevailing views of science and of learning and also a social-political agenda which supports these goals.

# TOWARD A PROGRESSIVE INTERPRETATION OF SCIENCE CURRICULA

William H. Schubert

Professor Connell's paper is, to my mind, a fine contribution to a very important problem: the understanding of the place of science and technology in cultural experience. I do, however, have some questions that I would like to offer as heuristic devices (perhaps in the spirit of Armstrong) with the intent that they might stimulate dialogue.

Why does Professor Connell limit the paper to secondary school curriculum as indicated in the title? It seems as though his analysis is as relevant to elementary, collegiate, and adult education as to secondary. I know that he is fully capable of discussing primary school curriculum, as evidenced in his writing on "Curriculum for Peace Education" that appeared in New Era in Britain and New Horizons in Australia.[1]

Initially, Professor Connell raises an overarching question for the paper: "To what extent is it possible to see a corresponding cultural change (as the result of the rapid growth of science and technology in this century) manifesting itself through the medium of the educational system?" He goes on to note that, "One of the principal themes of the history of education in the twentieth century has been the struggle for a cultural reassessment which would recognize the significance of science and technology as a major contributor to social and intellectual life, and would ensure them a correspondingly central place in the school curriculum." While **historians** may well have struggled with this problem, I see little evidence that practitioners and most educational researchers have seriously addressed it. Thus, another question is: How can serious dialogue be generated on both the **is** and the **ought** of the consequences of science and technology in culture?

This rather directly leads to my third question which deals with my interest in Professor Connell's characterization of science education throughout his paper. I tried to substitute some other terms for his reference to education in science and technology. I substituted history, humanities, even arts, and finally progressive education itself. The intent of the essay was not lost with these substitutions, and this observation is intended in a positive vein, not a critical one that sports an all-things-to-all-people argument. I think it is Connell's broad perspective on culture and history that allows for a discussion of curriculum to treat science and technology, and to incorporate them throughout the whole range of a progressive interpretation of education and culture.

What I find distressing (and illuminated indirectly as well as directly by Connell) is the character of the most recent surge of emphasis on education in science and technology (particularly in America), which seems devoid of the best attributes of scientific and technological inquiry. Implicit in the present press for funded educational research in

science and technology is a base and myopic pseudo-pragmatism, a single tendency toward what the ancient Greeks called **techne** (procedural knowledge). In Connell's writing I see a science that is informed by the search for **arete** (the quest for virtue, excellence, and goodness) as well as the quest for **techne**, its complement. Thus, my question: how can this broader and deeper conception of science be developed and nurtured? My remaining questions are variations on this theme.

How can the interpretation of science as mere measurement, with its tedious over emphasis on false precision, be broadened? Ironically, it is precisely such preciseness that overpowers and inhibits the spirit of inquiry, poetic imagination, wonder, and everyday problem-solving that has characterized our best scientists. This state of affairs resounds loudly and clearly throughout the hills of academe, from the debilitating laboratory manuals of secondary and elementary schools to doctoral programs that turn out graduates with an arsenal of technical skills under the fraudulent certificate of Doctor of Philosophy.

This same distinction is one that runs much deeper into the fabric of our culture and is reflected in two profoundly different orientations to science: one that unquestioningly serves national interests as contrasted with one that seeks meaning and direction within a global perspective; one that favors individualistic productivity, recognition, and reward as contrasted with social and ecological welfare; and a science that serves competition as contrasted with one in which cooperative efforts attend to a mutual and genuine consideration of consequences. It is the second half of each of these contrasts that would seem commensurate with Perry's productive notion of science as a humanity, developed so well toward the conclusion of Connell's paper.

Dewey well-represented this blending of science and the humanities in The Quest for Certainty when he said, "Knowledge falters when imagination clips its wings or fears to use them. Every great advance in science has issued from a new audacity of imagination."[2] And again, in Reconstruction in Philosophy he writes with perhaps greater fervor: "Surely there is no more significant question before the world than this question of the possibility and method of reconciliation of attitudes of practical science and contemplative esthetic appreciation. Without the former, man will be the sport and victim of natural forces which he cannot use or control. Without the latter, mankind might become a race of economic monsters, restlessly driving hard bargains with nature and with one another,..."[3]

It seems to me that the latter prediction is very much actualized today; it is discussed without pulling punches by R. Buckminster Fuller in his latest book, The Grunch of Giants, which depicts an anarchistic army of technocrats who have the cumulative effect of producing a "Gross universal cash heist" (the meaning of the "Grunch" acronym).[4] Through the literary device of a modern myth, Fuller paints the absurdity of multinational corporate business practices but points through such

practices to an unintentional but hopeful dissolution of national political boundaries.

Like Fuller, but in a quite different way, Connell expresses hope -- hope for science as a humanity and hope for a world perspective that contributes to peace and growth through intelligent uses of science and technology. I want to share his hope that curricular reconstruction can contribute substantially to cultural reconstruction. I sometimes wonder if the public interest and will are equal to the task. Just the same, I am grateful for the image of what Professor Connell argues could be, and I like to remind myself of Peter Medawar's admonition that hope is only found in proceeding.[5]

NOTES

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3. John Dewey, Reconstruction in Philosophy (Boston: The Beacon Press, 1948), 310.

4. R. Buckminster Fuller, Grunch of Giants (New York: St. Martin's Press, 1983).

5. Peter Medawar, The Hope of Progress (Garden City, NY: Doubleday, 1973).